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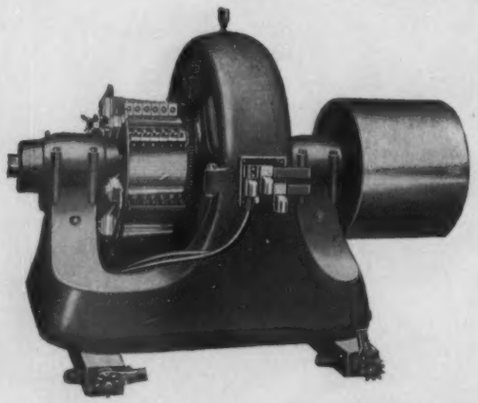

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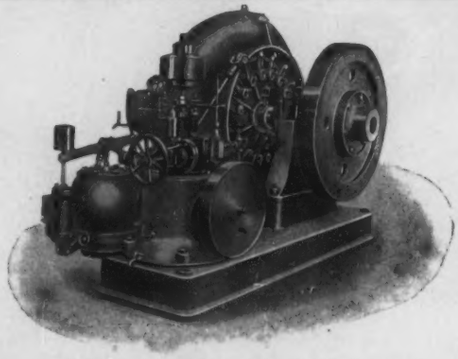

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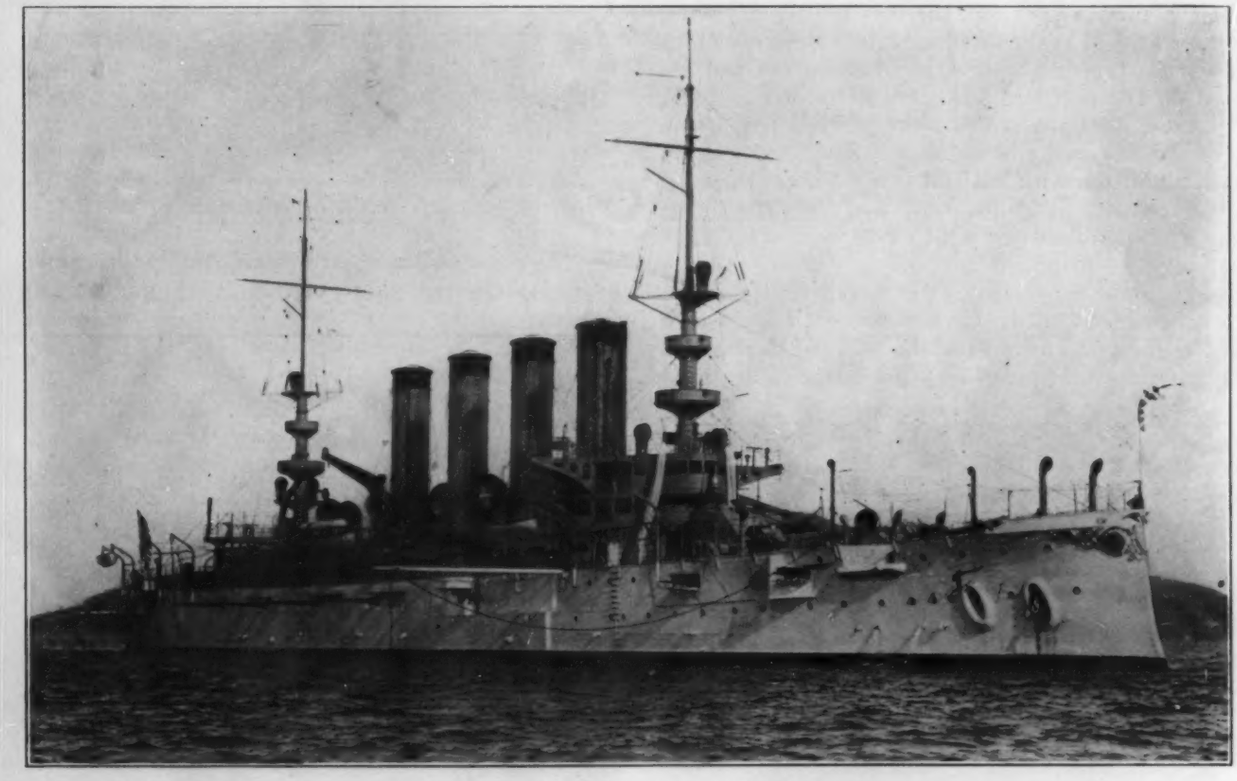
ELECTRICAL EQUIPMENT OF AN ARMORED CRUISER

BY L. ST. D. ROYLANCE.

Very little if anything has been written regarding the character and requirements of an electrical plant on board a man-of-war. It is evidently a subject with which but few engineers are familiar, and those who are, have no doubt considered it of not enough importance to mention in the various engineering discussions.

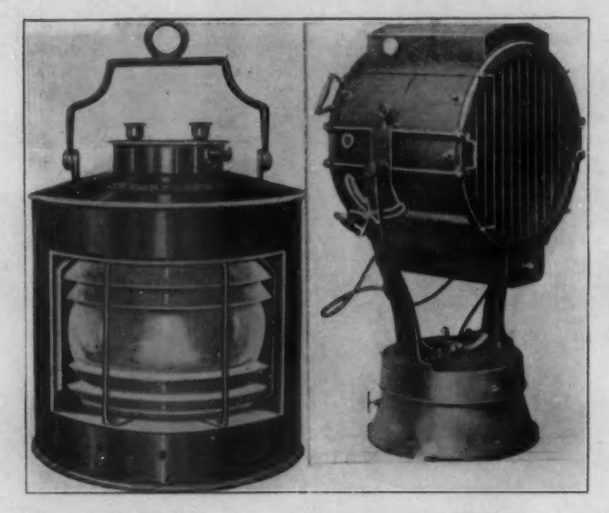


U. S. Armored Cruiser "California."

The writer will, therefore, endeavor to give in as brief manner possible, a description of the electrical installation on board the U. S. S. California, as well as the requirements exacted by the U. S. Navy. This armored cruiser was constructed by the Union Iron Works of San Francisco.

The installation consists in general of three 100 k. w. and four 50 k. w., d. c., generating sets, all of 125 volts pressure at the terminals; and a switchboard of sufficient capacity for the proper distribution of the electric current for lighting, power, etc. The lighting plant contains about 1400 branches and outlets consisting of the following fixtures and appurtenances; for rigging, etc., above main deck; top lights, Admiral peak lights, masthead lights, side lights, towing lights, double truck lights, and instrument lights. The lighting fixtures for general illumination throughout the ship are designated as follows: Single and double brackets, desk lights, ceiling fixtures Nos. 1 and 3, bulkhead fixtures, bunker fixtures, steam-tight globes, deck lanterns, battle lanterns, signal lanterns, magazine lanterns, diving lanterns, cargo reflectors, water-tight and non-water-tight portables and arc lamps which are installed in the fire and engine rooms; and 1/12 and

1/6 h. p. fans, and ¼ h. p. portable ventilating sets, which are also operated on the lighting circuits. There are also six 30-in. searchlights and two night signal sets.

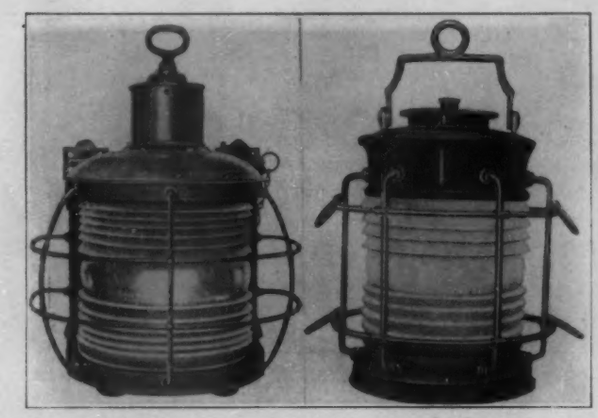


Side Light. Searchlight.

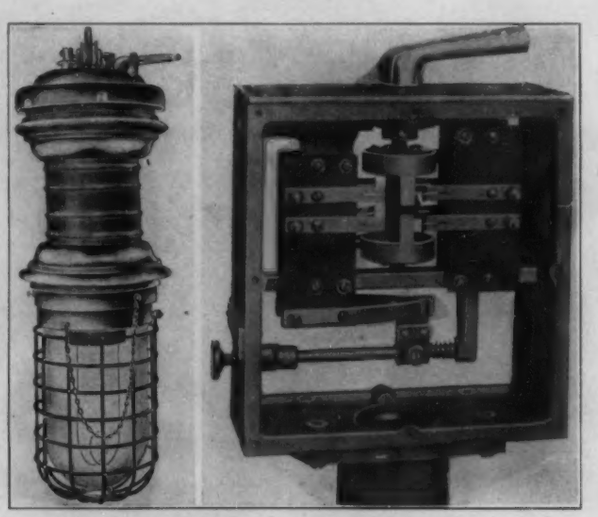
The Admiral peak lights and top lights are located at the mainmast upper top, the masthead and towing lights are located at the foremast upper and lower tops respectively, the side lights are red and green and are located on the port and starboard sides of the flying bridge, and the double truck lights are fitted to the tops of the foremast and mainmast, having two lights in each and fitted with red and white lenses; they are used for signaling and are controlled from the flying bridge by a double truck light controller. The night signal sets are installed, one on each mast, and are suspended from a specially constructed ladder which carries the set of four double lanterns, each fitted with a double lense, one of red and the other of clear glass. The lanterns are connected by means of cables to a keyboard for each set. The keyboard consists of a water-tight box containing the mechanism for connecting the various combinations; the mechanism consists of a plurality of quick break switches operated by depressing the different plungers or keys projecting through the keyboard; an interlocking arrangement is provided which prevents depressing more than one key at a time; a pulsator key is also provided for pulsating the lamps in the upper lantern. These keyboards are located one each on the after upper bridge and the forward flying bridge.

Night Signal Set Keyboard.

The six searchlights are located on specially constructed platforms, three each at the foremast and mainmast; they are so arranged that it is possible to cover any portion of the surface of the water with a beam of light. The searchlight currents are regulated by means of rheostats located at the searchlight switchboard, and the best results are obtained with a current of from 75 to 85 amperes at 48 to 55 volts pressure.



Masthead Light. Signal Lantern.



Arc Lamp and Double Truck Light Controller.

Ceiling Fixture No. 1. Ceiling Fixture No. 3. Steam Tight Globes.
Drop Light. Bulkhead Fixture. Deck Fixture.

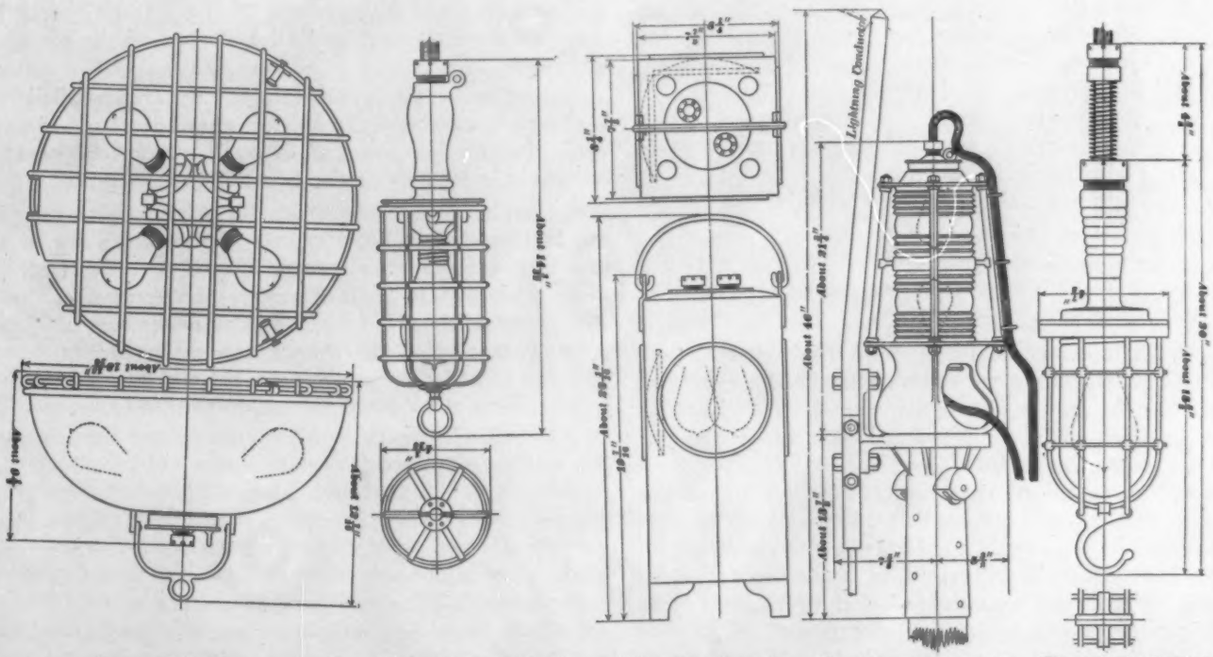
Lighting System.

The lighting system is arranged upon two circuits called the lighting and battle circuits. There are about 20 battle feeders feeding about 64 battle mains and 8 lighting feeders feeding about 18 lighting mains; making a total of 28 feeders and 82 battle and lighting mains throughout the ship.

The lighting circuits are for general illumination of the decks, passages and officers' and crew's quarters above the protective deck (a heavy steel turtle-back-shaped deck covering the most vital parts of the ship; the dynamo rooms, fire and engine rooms, steering gear and magazines). The battle circuits take in all decks above and below the protective deck and include the signal circuits. The battle circuits or mains are staggered, that is, a battle feeder feeds several mains in various parts of the ship, so that during action, should any feeder fail, no part of the ship will be in total darkness.

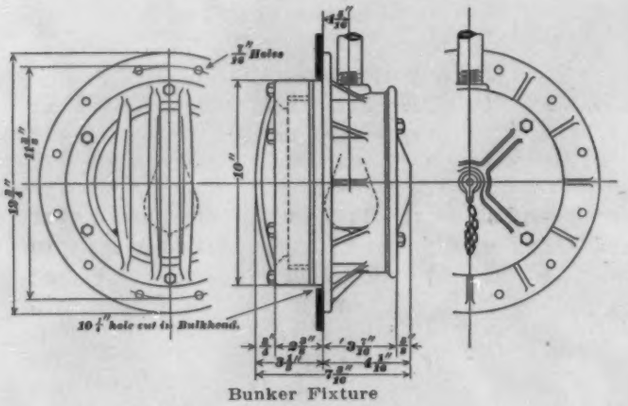
On the battle circuits no fixed lights are installed above the berth deck or outside of the armor belt, all being of the battle lantern type, or so located that no naked lights may be seen from the outside.

The single and double brackets are on the lighting circuits and are located in the wardroom officer's quarters. The desk lights and fans are located in the ward room, warrant and junior officers' quarters. The ceiling fixtures No. 1 are neat silver plated fixtures with frosted globes, containing 16 c. p. incandescent lamps and are used in the ward room officers' quarters. The No. 3 ceiling fixtures are much larger, having large, shallow, dome-shaped frosted globes and are used in the sick bay or hospital of the ship. The bunker fixtures are permanent fixtures which light only the coal bunkers and are on battle mains only. The magazine lanterns are portable to a certain extent, and contain two 16 c. p. incandescent lamps, each separately fused. The lamps are made permanent by being placed in fixed magazine light boxes. The bulkhead fixtures and steam-tight globes are practically the same, differing only in the method of installing. The steam-tight globe when suspended from the end of a conduit is called a drop fixture, when secured to a deck it is a deck fixture and when secured to a bulkhead is a bulkhead fixture; the only difference being in the position of the feet and conduit inlet. They are fitted with a helical spring socket, contain a 16 c. p. incandescent lamp which is enclosed by a steam-tight clear glass



Cargo Reflector. Non-Watertight Portable. Magazine Lantern. Double Truck Light. Watertight Portable.

globe which is protected by a heavy brass guard. The battle, deck and signal lanterns are almost identical, except for the battle lantern shutter, which is capable of shutting off all light. The deck lights are without shutters and the signal lanterns are the same excepting that the lenses are red, white, or green. The cargo reflectors are a special type of lamp cluster with a



Bunker Fixture

protected reflector, and the non-water-tight and water-tight portables are of a special type adopted by the U. S. Navy, and are used throughout the ship. The instrument lights are contained within the instrument which they illuminate, such as the binnacle, pelorus, etc.

Interior Communication System.

The interior communication system embodies all means of transmission of signals and messages and consist of the following systems:

1. Mechanical gongs.
2. Mechanical engine telegraphs.
3. Voice tubes.
4. Electric call bells, push buttons and annunciators.
5. Telephones.
6. Fire alarms.
7. Warning signals.
8. General alarm gongs.
9. Electric engine telegraphs.
10. Steering telegraphs.
11. Engine revolution and direction indicators.
12. Helm angle indicators.
13. Automatic electric steam whistle operator.
14. Electric log.
15. Battle order, range order and powder division instruments.
16. Long arm water-tight door indicators.

1. The mechanical gongs are used where a limited number of orders are to be transmitted. They are located in the main engine rooms, anchor windlass, at the foot of all chain ammunition hoists and at the top and bottom of each ash hoist.

2. The mechanical engine telegraphs are of the Navy Standard type and are located on and in the pilot house and in the conning tower, one for each engine. They connect with indicators in each engine room. The telegraphs are so arranged that those above the conning tower can be cut out by means of cut-out switches should they be disarranged or shot away in action. Likewise the telegraphs in the conning tower can be disconnected from the main lead, and are kept normally disconnected to reduce friction.

3. The voice tubes are installed between important stations where conversation is necessary. They are of solid hard-drawn brass 2 in. in external diameter, except in the conning tower where they are larger. At stations exposed to the weather, a solid hinged cover is fitted to the mouthpiece, making it water-tight. The whistles are in the wall of the mouthpiece. The voice tube terminals are mounted on water-tight boxes in places exposed to the weather and dampness, and on brass plates mounted on a hollow wooden base where not exposed. On these boxes or bases the mouthpiece and electrical calling apparatus are mounted, with the connections inside.

Where voice tubes lead from more than one station, a special form of three-way valve is installed, by means of which either station may be cut out or connected from the voice tube. All voice tubes have return calls except those for the ammunition hoists and between the pilot house top and pilot house. Voice tubes are installed under the main deck, except those from the conning tower to engine rooms, steering room and dynamo room, which are led through the armored tube. (The armored tube is a very heavy specially prepared nickel steel tube connecting the dynamo room with the conning tower, and through which all important circuits are run for protection when in action.)

4. The electric call bells, push buttons and annunciators embody the admiral and captain's calls, ward room officers' calls, junior officers' and boat hour gongs, warrant officers' calls, telephone ringing and all voice pipe calls.

Call bells and buzzers without reply are installed to call servants or subordinates. Annunciators are used where more than one call comes to a station, the non-water-tight type with buzzers being installed in pantries. At all other stations the water-tight annunciators with 3-in. water-tight bells are installed. The push buttons and buzzers are of the water-tight and non-water-tight types, and all bells are of the water-tight type.

Four or more 6-in. vibrating gongs are installed in various places about the ship to announce boat hours while the ship is in port. The push button for operating these is located on the quarter deck.

5. The telephone system is what is known as the Holtzer-Cabot Navy type system; consisting of a specially designed, water-tight telephone station complete with call bells and special Navy type, central energy switchboard with talking and calling motor-generators and all necessary apparatus for 42 telephones; 18 of which are water-tight and 24 non-water-tight. They are located throughout the ship.

The special features of the telephone system are the water-tight, cordless instruments and switchboard, double receiver and sound insulated transmitter. The cordless switchboard is arranged with extra large target signals and a multiple connection feature is included by which any one station can, if necessary, converse with five other stations simultaneously.

The system is so arranged that any station can be put into immediate connection with any other station

in the system by means of an attendant at the central switchboard. Current for signaling and talking is centralized at the switchboard. The call from the stations to the central switchboard is entirely automatic and the only movement necessary by the party using the telephone is to place one or both receivers to his ear, this movement transmitting the necessary signals and placing the calling station in connection with the switchboard operator. The station has also a shore line connection by means of which, the ship may be placed in communication with shore stations while in port. The telephone ringing circuit requires about 6.6 volts and the talking circuit about 24 volts. The currents for ringing and talking are taken from the central distribution switchboard, which is supplied by either battery, motor-generator or dynamotor.

6. The fire alarm system consists of about 71 mechanical thermostats installed in storerooms, coal bunkers and magazines. They connect with an annunciator placed at the captain orderly's station near the captain's quarters. The thermostats are set to operate at about 200 degrees F. for storerooms and coal bunkers, and about 100 degrees F. for magazines.

7. The warning signals consist of about 27 electric solenoid whistles located near the automatic closing doors and hatches. They emit from 10 to 15 shrill whistle blasts at an intermission of a few seconds each, before the closing of the water-tight doors. They are operated by two automatic contact makers located near the automatic water-tight door emergency switches; one in the pilot house and one on the quarter deck.

8. The general alarm system consists of four automatic clock switches or contact makers, located one each in the pilot house, conning tower, captain's stateroom and executive officer's stateroom, operating about thirty-two 12-in. single stroke electric gongs throughout the ship. They are used as general alarms for rousing the crew.

9. There is one complete set of electric engine telegraphs for each main engine, each set consisting of a combined transmitter and receiver on the bridge, in the pilot house and in the conning tower. These three instruments are all connected in parallel to a combined transmitting and receiving instrument in the engine room, the complete set of instruments thus comprising four. All instruments are similar in construction, except that an attention bell is installed in connection with the receivers in the engine rooms. The operation of these telegraphs is the same as that described for the steering telegraphs which follows.

10. The construction of the electrical steering telegraphs does not differ materially from that of the engine telegraphs; the interior mechanism being identical in each; a difference exists in the dials only. The system consists of five instruments; on the bridge, in the pilot house, conning tower, central station and steering-wheel room. All of these instruments are combined transmitters and receivers, being connected in a similar manner to the engine telegraphs. As the receivers are connected in parallel with the transmitter contacts, the lamps in the receivers will light when either transmitter arm is moved from the off position. For instance suppose the order "5 degrees port" should be transmitted from the bridge. The lamps behind the discs marked with this order in the receivers in the central station and steering room will light simultaneously and the attention bell will ring. The man whose duty it is to receive the orders will immediately move the pointer on his instrument to the lighted disc, lighting the lamps behind the corresponding discs in the conning tower, pilot house and on the bridge, thus signifying to the person who transmitted the order in the first place that it has been understood and carried into effect.

11. The revolution and direction indicators are on the flying bridge, in the pilot house and conning tower, one for each engine. They are mounted on the engine telegraph transmitters. The indicator consists of a circular water-tight case with plate glass face. The dial is of white porcelain and is marked "ahead" and "astern" just over two small pointers. The pointers are operated by electro-magnets which are controlled by two eccentrically geared contact makers fitted to the main engine shafts. The pointers pulsate at each revolution, and register ahead or astern only when the attendant presses a water-tight push button which controls the lighting current for illuminating the dial and about 6 volt current for operating the pointers.

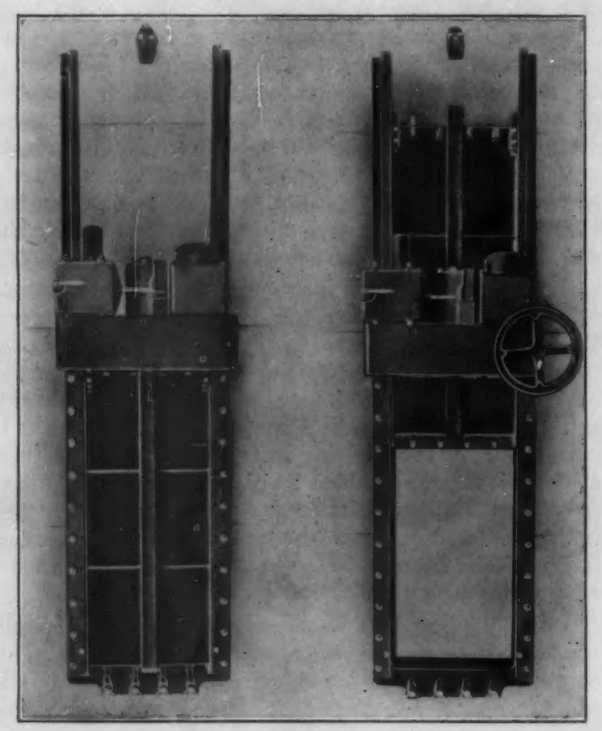
12. There are six instruments in the helm angle indicator system; one transmitter and five indicators. The transmitter is located in the steering engine room, the indicators in the following locations, viz.: on the bridge, in the pilot house, conning tower, central station and steering-wheel room. The transmitter is mounted over the steering gear and is operated from a sheave on the rudder head. The indicators are somewhat similar to the engine and steering telegraph indicators, and register the position of the helm or rudder . The current for operating same is taken from a battle lighting circuit.

13. The automatic steam whistle operator consists of an automatic and at will operating switch; it contains a clock and is located in the pilot house. It can be arranged to automatically blow an electromagnetically operated steam whistle for six seconds per minute, etc., and is used in foggy weather and also for signaling by hand.

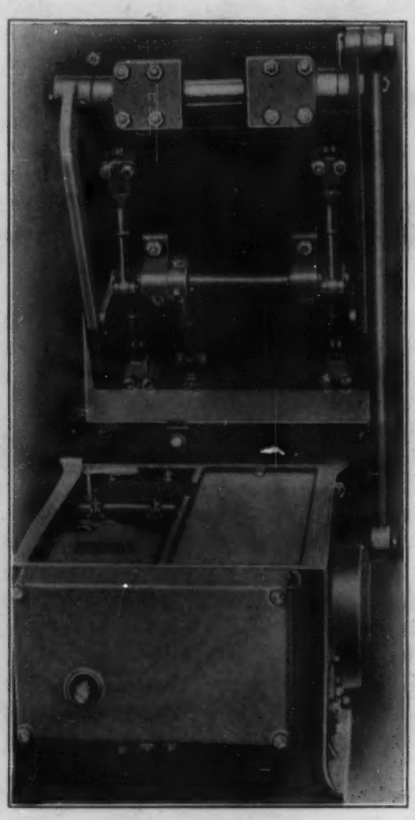
14. The electric log consists of two electric log transmitters, telltale indicator and an electric log indicator. The transmitters are located on the port and starboard after sides of the ship near which is located the telltale. They connect with and operate the log indicator in the pilot house. By means of the telltale, those in charge can tell at a glance whether the transmitters are working properly. The object of this appliance is to give in the pilot house, without recourse to passing the word along the deck, the reading of the log and also a continuous totalized record of the knots traveled.

15. The battery control is an elaborate system. In general it enables the commanding officer from a central station to communicate battle orders, ranges and deflections to all parts of the ship, by means of transmitters, indicators, etc. The operating current is taken from a special battery control switchboard in the central station which is fed from the battle lighting circuits. (The battery control system has since been superseded by a new system of battery control.)

16. There are about thirty electrically operated water-tight doors and hatches. They are controlled by an automatic emergency switch located in the pilot house; in connection with this switch is an indicator. As each door or hatch is closed it operates an automatic switch which connects a 5 c. p. lamp in the indicator at the emergency switch. The circuit for lighting these lamps is completed through a switch operated by a button through the cover of the indicator. When this button is pressed the lights corresponding to all the closed doors and hatches will glow, and through the numbered translucent discs in the cover the operator is able to determine exactly which doors and hatches have responded to the emergency station.



Watertight Door.



Watertight Hatch.

Power System.

The electric power system consists of about 43 power feeders supplying about 100 power mains, which in turn supply current for about 140 motors; made up of water-tight door and hatch motors, chain ammunition hoists, turret ammunition hoists and rammers, exhaust and blower ventilation motors, gun elevating and turret turning motors, fresh water pump, dough mixer and dishwasher motors; laundry and machine shop motors; air-compressor motors, electric deck winch motors, boat crane motors, and motor-generating sets.

There are about 30 water-tight doors and hatches. They are located between the coal bunkers and fire-rooms and water-tight compartments below the protective deck and are operated by motors of a special type and design rated at 1 h. p. each.

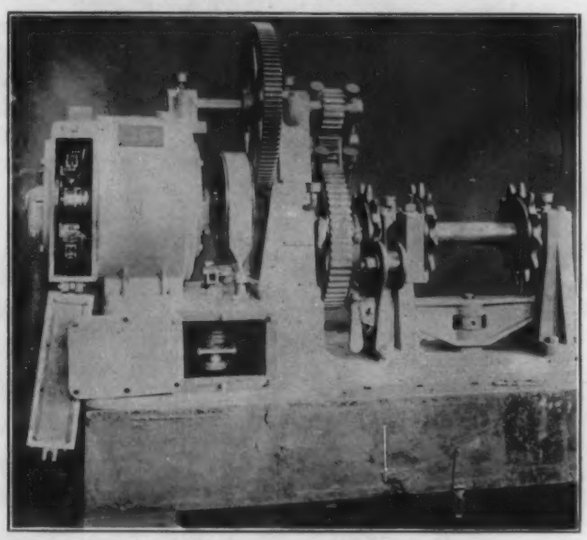
The chain ammunition hoist motors number about 34. They were specially built by the Union Iron Works. The chain hoists are used for raising ammunition from the ammunition handling rooms and passages to the gun decks for distribution to the guns. They are of the endless chain type, consisting of two endless chains running over sprockets at the top and bottom of the hoist trunks. The two chains are connected at intervals by carriages. The up-going and down-going chains are separated by means of partitions in the trunks. The hoists have feeding tables at the bottom of the hoist trunks, so arranged that as the amunition is fed it will be carried up the trunks on the carriages and delivered on the deck at the upper ends. The hoists are driven by 2.5 h. p. shunt motors, through friction drives which will permit the motors to revolve without damage should the ammunition for any reason jam in the hoist trunks. The motors are reversible and are controlled by specially constructed Ward-Leonard starting boxes and reversing switches, in the construction of which sparking is reduced to a minimum, as it is imperative that there shall be no sparks near ammunition.

There are four turret carriage ammunition hoist motors installed, two in each turret; one for each gun. They are General Electric 4-pole, shunt wound, have an output of 11 h. p. each and require at full load about 80 amperes at 125 volts, and are operated by the Day control system. The Day system of motor control consists essentially of the introduction of a variable resistance in the motor armature circuit. In lowering, the motor is operated as a generator, being run by the weight of the car. The speed is regulated by the amount of the resistance introduced in the armature circuit. The controller is of the drum type and provides for the operation of an electro-magnetic brake, for introducing steps of resistance for hoisting and for lowering and for short-circuiting the armature on the

off position and on the first lowering position.

When the car is hoisted with ammunition, it is stopped and locked in the proper position for ramming the projectile and powder into the breech of the gun. This is accomplished by means of a telescopic rammer operated by an electric motor, controlled by a drum controller. There are four of these rammers; two in each turret, one for each gun. The motors are series wound, of 3.5 h. p., and drive the rammers through a slip-clutch which relieves the motor when the rammer has reached the limit of its travel. The current required at full load is about 26 amperes at 125 volts. (The ammunition hoists and rammers described above have since been superseded by a new system of ammunition control.)

The turret gun elevating equipment is operated on the Ward Leonard system of motor control. The



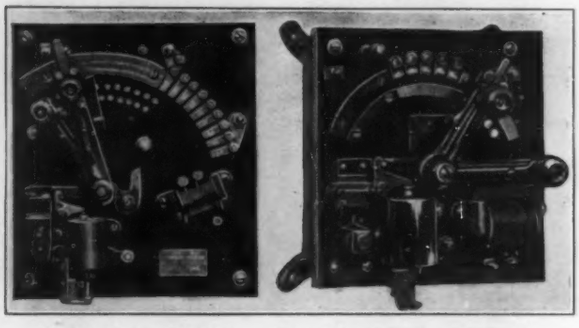
Chain Ammunition Hoist.

control is similar to that of the turret turning system. A motor-generator set is used instead of one of the steam generating sets. There are four motor-generating sets and four elevating motors installed; two motor-generating sets and two motors for each turret; one generating set and one motor for each gun respectively. The motor-generators are General Electric, have an output of 4.7 h. p. and require at full load about 39 amperes at 125 volts. The motors are also of the General Electric Co. make, have an output of 3½ h. p. and require at full load about 27 amperes at 125 volts The controller or controlling rheostat is located under the gun pointer's sighting hood, secured to a bracket which is a part of the gun-sight bracket. The arrangement of the controller is to control the speed of the motor by the usual process of varying the potential of the generator field, but reversal is accomplished by reversing the direction of the current in the generator field, the connections of the elevating motor terminals and generator terminals remaining fixed and direct.

The electrical apparatus for turret turning consists in general of two 15 h. p. shunt wound motors located right and left in the base of the turret on a level with the gun deck; a motor board, installed in the same compartment; a controller, rheostat, circuit breaker and ammeter located in and turning with the turret, and one of the ship's generators. The motors are of the General Electric Co. shunt wound 125 volt enclosed type, rated at 15 h. p. each. They take a full load current in the armature of 105 amperes at 400 r. p. m., with 2.5 amperes in the fields. The system of control is a combined Ward-Leonard and motor-field weakening control.

The Ward-Leonard system of turret control is capable of a wide range of speed, with very fine increments of variation. The turret turning speed is from ¼ degree per minute minimum to 100 degrees per minute maximum, between which there are about 70 variations and the turret can be started from rest and brought to full speed in 10 seconds and can be stopped in five seconds' time.

The operation of the turret turning system is as follows: The armature of a separately excited compound wound generator with its series field short-circuited by a low resistance shunt, allowing only a small portion of the armature current to flow through it, is directly connected with the armatures of the two shunt wound separately excited motors arranged in series. The shunt field of the generator is supplied



Ward-Leonard Starting Boxes for Blower and Hoist.

from the power mains, and the line voltage is varied up to a certain point by the controller. The shunt fields of motors are also supplied from the power mains, and the line voltage is varied by the same controller after it has ceased to affect the generator field.

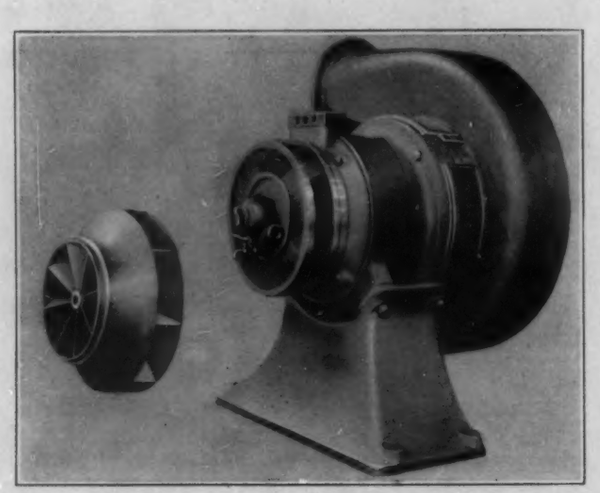
In the off position of the controller, and supposing switches to be closed, there is a weak current through the generator field, and line voltage of the motor fields. As the controller in the turret is turned by the operator to the first running position the voltage of motor fields remains as it was, but the resistance in circuit with the field of the generator is decreased, causing low voltage in the turret turning armatures and the slowest speed of rotation of the turret. Successive steps on the controller gradually cut resistance out of the generator field which increases the voltage at the turning motors and the speed of rotation of the turret. Except with controller in "off" position, the turning motor armatures are in series with the generator full line voltage in the fields and the speed of rotation of the turret has increased from minimum to one-half maximum. Normal voltage is now being impressed on the two motor armatures, and as they are in series, each takes one-half the line voltage.

Further operation of the controller cuts resistance

in series with the turning motor fields, causing further increase in speed of rotation of the turrets up to the maximum.

(1)	(2)	(3)
Normal motor fields, low impressed armature voltage.	Normal motor fields, normal impressed armature voltage.	Weakened motor fields normal impressed armature voltage.

In case of failure of one of the turning motors, it can be thrown out of circuit by opening its armature and field switch on panel in barbette. The armature switch must be seated in the circuit closing clips provided. When the field switch of a motor is opened the short-circuiting clips throw the other motor field directly across the line which cuts out the field weakening control, and the system is now ready for operation on the Ward-Leonard system using one motor only. Every controller position will now give approximately double the speed that was given when using two motors, because double the line voltage is being impressed on the single motor armature and when the controller is turned to that position at which normal voltage is impressed on the armature of the turning motor, any further movement of the controller will cause no change in speed.



Union Iron Works Ventilating Set.

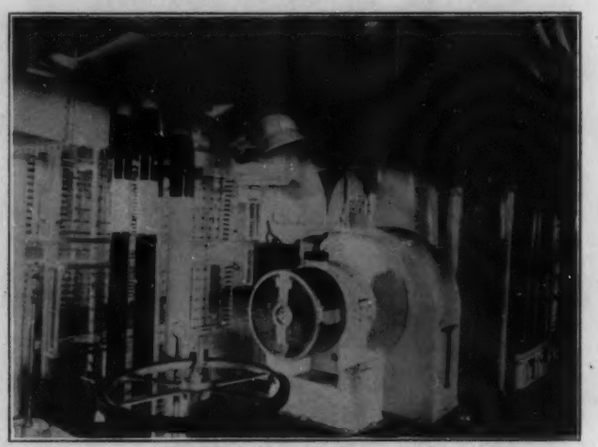
There are about 28 ventilating sets, the motors of which range from .6 to 16 h. p. each. The motors are shunt wound, capable of a wide range of speed variation by means of field control. They are equipped with Ward-Leonard field regulation motor starters.

The artificial ventilation of the ship is by means of electrically operated exhaust and pressure blowers. The motors are directly connected to the fan runners and both motor and fan are mounted on a base common to both. In the ventilation system air is supplied to the different compartments under a pressure of from 2 to 6 lbs. per sq. ft. Each compartment has its own system and such compartments as the lower dynamo room, etc., the foul and hot air is carried away by exhaust blowers and fresh air supplied by pressure blowers.

The dough mixer and dishwashing motors are directly connected to the machines they operate and are of 2.5 and 1 h. p. each, respectively. The laundry motor is a General Electric 7.5 h. p. shunt wound motor. It is used for driving the washing machines, mangles, etc. In the machine shop, there are two Union Iron Works 5 h. p. shunt wound motors. They are used for driving the various machine tools, such as planer, shaper, lathes, etc. There are two fresh water pumps, driven by two Union Iron Works 3 h. p. shunt wound motors which are geared direct to plunger pumps.

There are two four-stage torpedo air compressors capable of furnishing 30 cu. ft. of air per hour at 2500 lbs. pressure per sq. in. The motors are semi-enclosed, shunt wound and are directly connected to the compressors. They are six pole and have six sets of brushes and their capacity is 50 h. p. each when running 500 revolutions and using 350 amperes at 125 volts.

There are four boat cranes; one of 33,000 lbs. capacity, one of 17,000 lbs. and two of 5,600 lbs. capacity each. Each crane is equipped with two motors, one for hoisting and lowering and one for rotating. They are connected to the gearing of the hoists through slip-clutches and each motor is fitted with an electric brake. They are controlled by drum controllers using the Day system of control. The boat cranes are used for handling all the small boats and launches, and also for coaling ship.



Motor Driven Ventilating Set.

The Day system of control is well adapted to boat cranes, and when lifting and lowering, the loads are strictly under the control of the operator.

The boat cranes are equipped with Union Iron Works shunt motors. The 33,000-lb. crane having a 50 h. p. and 30 h. p. motor for lifting and rotating and requires at full load 360 and 208 amperes respectively at 125 volts; the 17,000-lb. crane is equipped with a 30 h. p. and 20 h. p. motor and the full load currents are 208 and 146 amperes; and the two 5,600-lb. cranes are equipped with 20 and 15 h. p. motors for lifting and rotating respectively and the full load currents are 146 and 108 amperes at 125 volts.

During the acceptance tests, all motors were obliged to handle a load of double the weight of the heaviest launch, and also tests were made to ascertain whether the control would be affected by any movement of the ship; such as rolling and pitching to the extent of 10 degrees. The maximum loads were raised and lowered slowly and rapidly and exactly, at the will of the operator.

There are seven deck winches, each fitted with General Electric Co. 30 h. p. series wound enclosed motors, and controlled with drum controllers. They are capable of being reversed, and by means of change gearing, double the load can be handled at half speed or normal load at normal speed. The winches are used for shipping cargoes, coaling ship, etc.

The Main Switchboard.

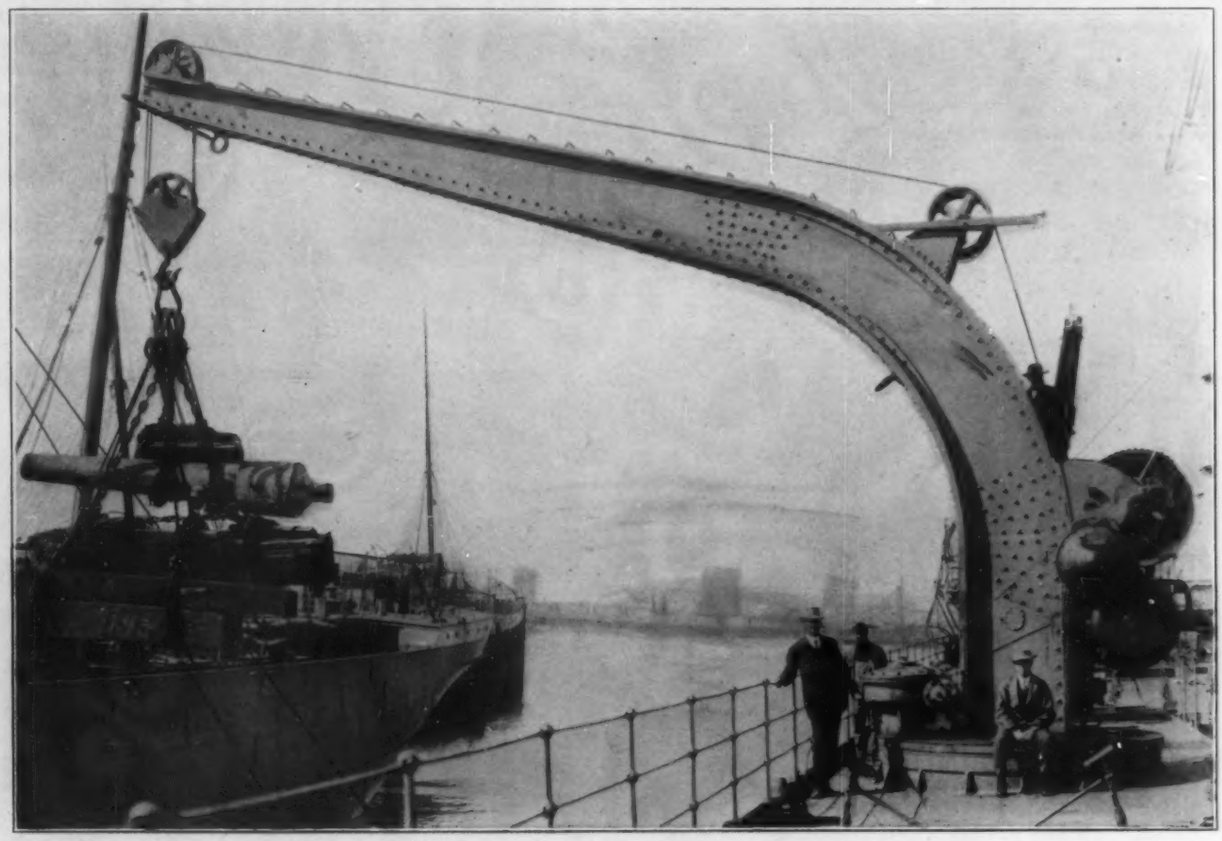
The main switchboard, consisting of enameled slate panels for four 50 k. w. and three 100 k. w. generators, one light distributing panel and one power distributing panel, is located in the upper dynamo room. This switchboard, a diagrammatic sketch of which is shown in the accompanying illustration, is generally arranged in such manner as will allow any number of combinations of dynamos to be run on any circuit or combination of circuits. These circuits are five in number, viz.: Searchlight, lighting, power, forward turret turning and after turret turning.

To accomplish this the negative pole of each machine can be connected by a single-pole, single-throw switch to a horizontal common negative bus bar, whereas there are seven vertical positive generator bus bars, one for each machine. Back of these bars are five horizontal positive circuit bus bars, and where these two sets cross, there are single-pole, single-throw switches which allow the positive leg of each, any, or all the dynamos to be connected to each, any or all circuits, with the exception of the three 100 k. w. generators, which do not connect with the turret turning bus bars. Therefore, there are $5 \times 4 + 3 \times 3 = 29$ points of contact on the positive bus bars.

For paralleling the dynamos there are two separate equalizer bus bars, one for lighting and another for power (there being no occasion for paralleling machines on searchlight circuits). Such dynamos as may be desired are connected to these equalizer bus bars by removable blade plug swicthes. The two turret turning bus bars are not considered here, but will be described later.

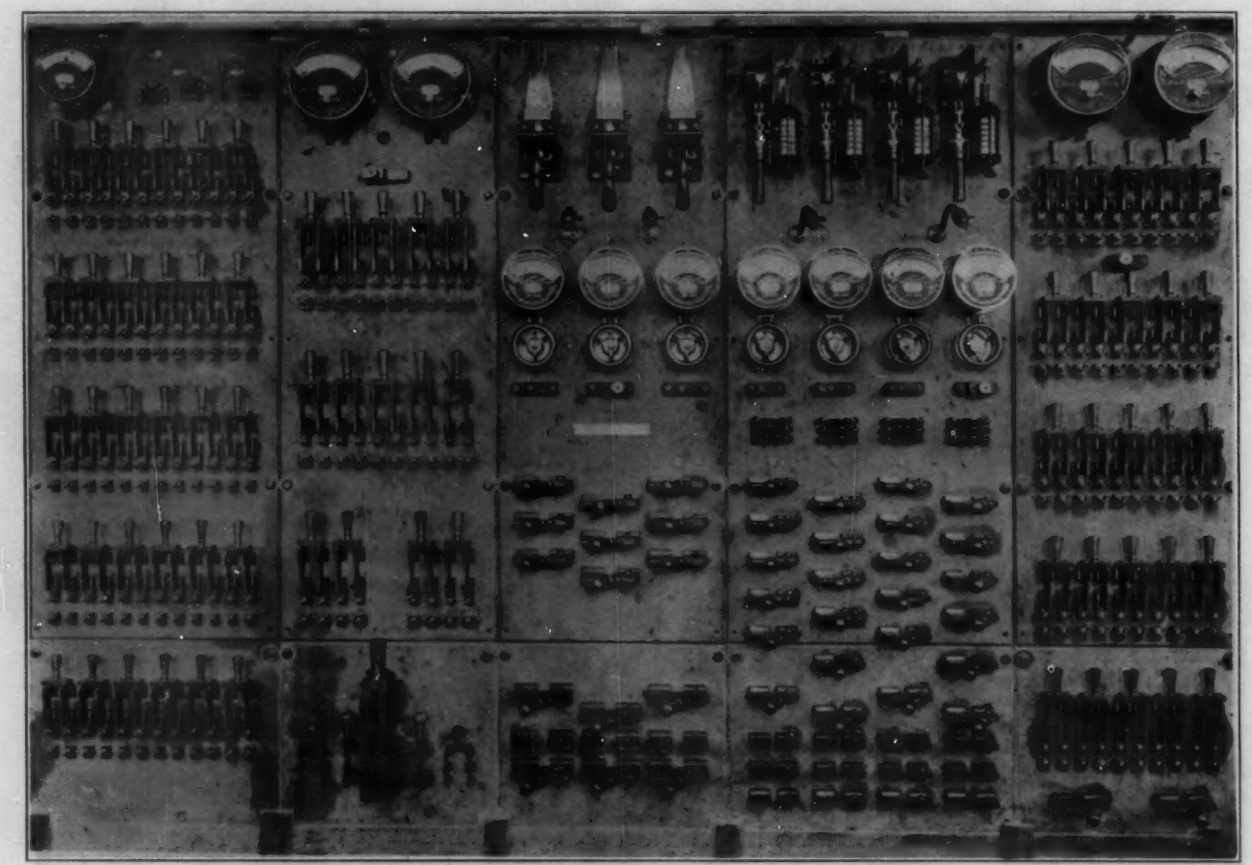
The two dynamo panels are arranged in vertical sections, one section for each machine. Each section contains all the apparatus necessary for the operation of its own dynamo. Starting at the top of the panel we have first the circuit breaker, then the ammeter, then the ammeter shunt (on the back of the board), then the hand wheel for operating the field regulator or rheostat, which is operated by a spindle passing through the slate panel. Next comes the plug receptacle for connecting to the voltmeters, and then three single-pole, single-throw positive dynamo switches by means of which the dynamo may be connected (proceeding in order, starting with the upper switch) First, to searchlight bus; second, to lighting bus; third, to power bus for 100 k. w. generators only; fourth, to forward turret turning bus; fifth, to after turret turning bus for the 50 k. w. generators in the same vertical row. But on the lower panel there are three single-pole, single-throw switches. The upper one connects the negative leg of the dynamo to the negative bus bar, the middle one connects the lighting equalizer and the lower one the power equalizer.

On the right hand (or 50 k. w. generator) panel, there are eight three-pole, single-throw field-control



33,000 lb. Boat Crane Handling Steel Weighing 66,145 lbs.

switches, the hinged ends of which connect to the terminals of the shunt fields of the 50 k. w. generators. The field-control switches allow three methods of field excitation: By closing the two upper switches the machine is made self-exciting; by closing the two middle switches the machine is separately excited and controlled from the forward turret by the Ward-Leonard system described elsewhere; by closing the two lower switches the machine is separately excited and controlled from the after turret.



Main Switchboard.

Power Panels. Generator Panels. Lighting Panel.

When the dynamos are used to operate the turret turning motors, the series fields are short-circuited through the shunts which are located on the back of the lower panel and are controlled by single-pole-single-throw switches at the base of the board, one switch to each machine. Referring to the figure, it will be noted that the switches of generator No. 4 are set for operating the after turret and that of generator No. 7 are set for self-excitation only.

On the lower left-hand, or power, panel there are three vertically-set, single-pole, single-throw, and two double-pole, single-throw switches with shunt attachments. The middle one connects the negative power distributing bus to the common negative bus, and the outer ones perform the same function for the negative turret leads; the switch for the forward turret being on the left-hand side. The two double-pole switches connect to the fields of the turret turning motors and are so arranged that the operation of opening the switch directs the discharge of the field coils through the shunt resistance coils located on the back of the lower panel.

To the left of the generator panels is the power distribution panel carrying 44 single-throw, double-pole switches. Arranged at the top of the panel is a voltmeter ground-detector with a six point switch connecting with the five positive bus bars and the common negative. There is also an ordinary lamp ground-detector, with lamp receptacle which is provided with a switch for breaking the ground connection (this operation being necessary before using the voltmeter ground-detector). This panel also contains two voltmeters with plug receptacles underneath.

At the bottom of the right-hand, or lighting, panel there are two single-pole, single-throw switches. The left-hand one of these connects the negative lead to the searchlight panel (hereinafter described) to the common negative bus. The right-hand switch performs a similar function with respect to the negative light distributing bus bar.

All switches horizontally placed on generator panels are hinged on dynamo end and throw to the left. For the equalizers, removable blade, plug switches are used. Four blades are provided for each equalizer, and two for each of the other circuits. i. e., forward turret, after turret and series shunt. When a switch is open the clip is plugged with a stop, to prevent accidental closing. Should it be desired to operate all seven generators in parallel, they may all be equalized on either the light or power equalizer bar.

The voltmeter connections are shown in the diagram, the plug receptacle on the power panel and the three receptacles of the left dynamo panel, i. e., for machines Nos. 1, 2 and 3, have a spacing of 1 inch and 2 inches, whereas the receptacles on the lighting panel and those for machines Nos. 4, 5, 6 and 7 have a spacing of 1½ and 2½ inches. By using the 1-inch plug in any receptacle on the dynamo panel the voltage is read on voltmeter No. 1. Likewise, by using the 2-inch plug, the voltage can be read on voltmeter No. 2. Similarly, on the right hand dynamo panel the 1½-inch plug throws voltmeter No. 3 across the dynamo terminals and the 2½-inch plug throws voltmeter No. 4 across the terminals. Thus we can read the voltage of any two machines on the left hand panel and of any two machines on the right hand panel (four machines in all), simultaneously.

the receptacle is made complete when the common negative generator switch is closed; fourth, plug to voltmeter and adjust voltage by field regulator; fifth, and last close positive swtich.

For detecting grounds, the lamp detector on the upper part of the power panel is connected permanently across the common negative bus and the positive leg on the lighting circuit bus, and when using the voltmeter ground detector the ground connection on this lamp ground detector must be broken by opening the ground switch. The connections to the voltmeter ground detector are such that when a circuit is grounded on the positive leg, the instrument will indicate when plugged to negative, and for a ground on the negative of any circuit, the instrument will indicate when plugged to any of the positive circuit bus bars; provided that said bar is alive, and here it should

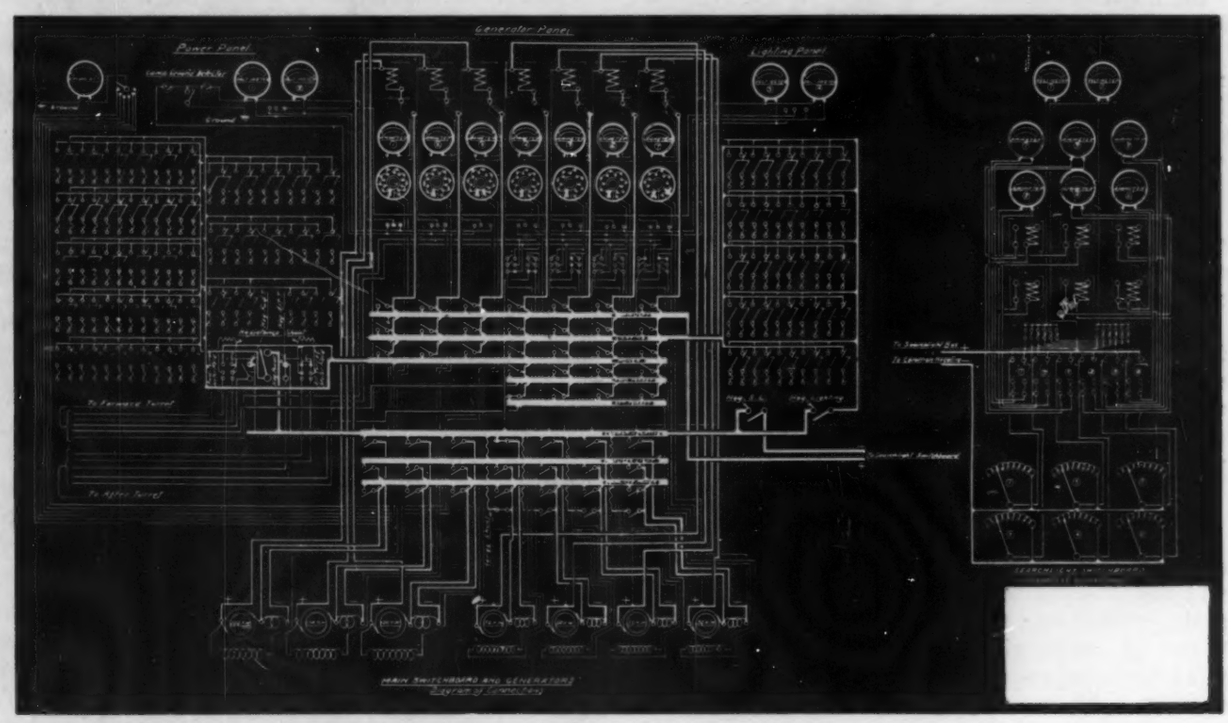


Diagram of Connections of Main and Searchlight Switchboards.

With the 2-inch in a receptacle on the dynamo panel and the 1-inch plug in the receptacle on the power panel, we have voltmeter No. 1 in parallel with voltmeter No. 2, for calibration. With the 1-inch plug in a receptacle on the dynamo panel, the 2-inch in the receptacle on the power panel, and the 1½-inch plug in the receptacle on lighting panel, voltmeters Nos. 1 and 3 are in parallel. By substituting the 2½-inch plug for the 1½-inch plug in the above arrangement Nos. 1 and 4 are in parallel. As only one plug of each spacing is furnished, it is impossible to make a short circuit or parallel two machines on the voltmeter connections. An inspection of the diagram will show this to be true.

When starting up a new machine to be parallel with one already running, the operation at the switchboard is as follows: First, close the equalizer switch; second, close the circuit breaker; third, close the switch to common negative the voltmeter connection up to be noted that a bar is alive when any switch in the horizontal row connecting to it is thrown.

Searchlight Switchboard.

The searchlight panel is located near the main switchboard; it consists of a single enameled slate panel set in an iron frame, and has mounted upon it the various instruments and accessories for the searchlights in the following order; at the top of the panel are the common voltmeters for all six search-lights; next come the six ammeters, three abreast and then six double pole G. E. Company circuit breakers similarly placed. Below these are the plug receptacles for the voltmeters, then six double pole, single throw switches, fused, and finally at the bottom of the board, are the adjusting levers and contacts for the regulators. The latter are mounted back of the searchlight panel and are connected with their contacts by means of cables.

Referring to the figure showing the diagram of connections, the negative lead from the switch on main board connects to a common negative bar behind the searchlight panel. This supplies one side of all regulators; the other side being connected to the respective circuit switch. The positive side of each circuit switch is fed by the lead from the positive searchlight bus bar on main board. From the circuit switch the negative lead to each lamp connects through the right hand side of the circuit breaker and thence to the lamp. The positive lead passes through the ammeter to left hand side of circuit breaker, thence to the lamp.

The voltmeter connections are made in the following manner; the voltmeter positive is connected directly to the positive bus bar, and the negative to the six upper contacts of the voltmeter receptacle. The six lower contacts of the latter are connected in order to the negatives of the six switches (on the regulator side).

Two voltmeter plugs are supplied and these, when inserted vertically in any one of the set of six pairs of contacts, completes the circuit through the voltmeter, which shows the voltage across the feeders; the voltage across arc of lamp (plus drop of voltage on feeders), being indicated.

There are two voltmeters and two receptacles of six pair of contacts, each mounted on the panel, thereby enabling readings to be taken in parallel for calibration, or the voltage may be read from any two lamps.

The ground detector, volt and ammeters are of Weston Round pattern type; the circuit breakers and searchlight rheostats are G. E. Co.; the field rheostats are The Ward-Leonard round enameled type; all of the switches are of the Navy Standard type and made by the Union Iron Works.

System of Current Distribution.

The lighting and power systems are subdivided as heretofore mentioned under caption of "Lighting System" and "Power System," in accordance with the usual practice, into the requisite number of circuits. On the lighting panel there are 25 switches; these with the exception of one that controls the feeder for wireless telegraphy, are employed in connection with the lighting feeders which, in turn supply their respective mains and branches.

The power circuit panel is supplied with 44 section switches. These control all power circuits except the two for turret turning, which are fed from the turret bus bars, as heretofore described.

The size of feeders, mains, etc., and means of installing are in accordance with the Bureau of Equipment, Navy Department specifications for installing electric plants and electrical means of interior communicatioins on board ships of the United States Navy The maximum load for feeders for lighting circuits does not exceed 75 amperes per feeder. This is based on a basis of 0.5 of an ampere for 16 c. p. incandescent lamps or 1/12 h. p. fans, and 1 ampere for 32 c. p. incandescent lamps of 1/6 h. p. fans.

Several mains of the same class of service may be grouped on the same feeder, provided the total load is not in excess of 75 amperes. The cross sectional area of the feeders and mains are such that the fall in potential from the dynamo terminals to the most distant outlet does not exceed 3 per cent at the normal load of the feeder. Also the feeders and mains must have a cross-section of not less than 1,000 circular mils per ampere at the normal load.

Power feeders and mains for continuous service; such as ventilation, laundry and machine shop motors, must have a cross-sectional area of 1,000 circular mils per ampere, and not less than 500 circular mils per ampere for intermittent service; such as ammunition hoist, boat crane and winch motors.

Motors whose normal full load working currents are less than 50 amperes are grouped on the same feeder, but no such feeder has a load in excess of 100 amperes. Each motor whose normal full load working current exceeds 50 amperes has a separate feeder, and the cross-sectional area is such that the fall in potential from the dynamo terminals to the motor terminals does not exceed 5 per cent at normal full load. For motor feeders carrying more than one motor, the fall in potential from the dynamo terminals to motor terminals does not exceed 3 per cent at total full load. Where mains are lead off from feeders it is done through Navy standard junction boxes, having double pole fuses, which on lighting circuits blow on the basis of 1 ampere per 500 c. m. of the main; and on the power circuits blow at double the normal current of the motor.

The two feeders supplying the lighting mains of the main engine rooms are arranged with interconnecting switches. Should either feeder for any reason fail, the two engine rooms may be carried on one feeder; in which case, the area of such interconnecting feeders is 1,500 c. m. per ampere.

Method of Installing

The ship is wired on the two-wire system. The method of installing the electric light and power and interior communication circuits consists of a combination of steel and brass enameled conduit; the conduit is used throughout the ship and is insulated as follows:

The enameled conduit is made up of standard gas pipe sizes. The enamel consists of three coats baked on, inside and out, and is not affected by moisture, alkalies, etc. Brass conduit, which is insulated in a similar manner as the steel conduit, is used in magazines and an the superstructure where wiring in conduit is run within twelve feet of the standard compass.

Conduit is made water-tight through bulkheads and decks by means of bulkhead stuffing tubes and deck stuffing tubes. Gland couplings or water-tight boxes are also used on conduit where it passes from the non-water-tight to a water-tight compartment; and on every lead of conduit between two junction boxes in order to prevent water from passing from box to box should one become flooded. Where conduits terminate at a bulkhead or otherwise, terminal tubes are used. The deck tubes and bulkhead stuffiing tubes are used on the interior communication installation as well as for the light and power.

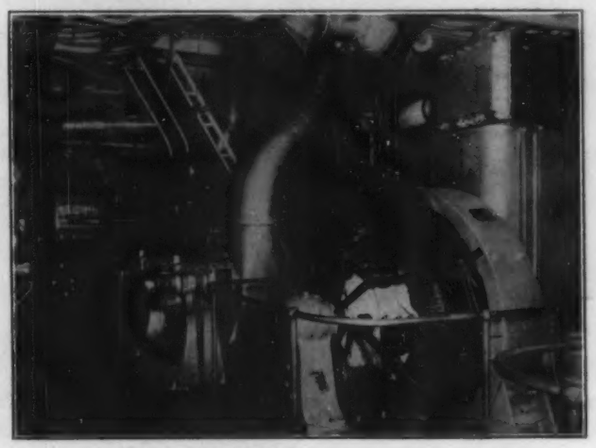
Conduit is made continuous where run through decks, by means of a combination of Navy standard washers and nuts, together with a gland coupling, it is run through water-tight bulkheads by means of Navy standard bulkhead stuffing boxes, which allow for play of the bulkhead on the conduit. A water-tight box is used on conduit where it passes through

a non-water-tight compartment to a water-tight compartment, in order to prevent flooding, should a break in the lead occur.

Conduit is secured to the beams or bulkheads with suitable iron straps. Conduit wiring accessories used are of the Navy standard type, adopted by the Bureau of Equipment. Great care is taken to see that covers on all distribution boxes, feeder boxes, junction boxes, switches and switch and receptacles are securely fastened. Fixtures and accessories in the engine and fire rooms are most liable to injury from loose covers when washing down, and only electricians or those in authority are allowed to open boxes for inspection or for renewing fuses.

Method of Marking Circuits.

A glance at the network of conduits shown above the engine and switchboard will substantiate the necessity of an elaborate system of marking circuits. All conduits and voice pipes are marked with a capital



Upper Dynamo Room, showing 50 k. w. Generating Set and Switchboard.

letter designating the character of the lead as follows: Lighting Feeders, Battle Service, B; Searchlight Feeders, B; Lighting Feeders, Lighting Service, L; Power Feeders, P; Interior Communication Leads, I; Voice Pipes, V.

All battle, searchlight and power feeders are numbered serially as B-1, L-14, P-46, etc., the numbers corresponding to the approved wiring plans.

All voice pipes are numbered serially in accordance with the approved list, as V-1, V-2, etc.

All mains and branches on the battle, lighting or power feeders are numbered serially and are given a small case letter b, l or p, respectively, proceeded by the serial number of the main and followed by the serial number of the feeder, i. e. mains on B-14 are numbered 1-b-14, 2-b-14, 3-b-14, etc.; main 1-b-14 is the one branching off the feeder at that point in its run which is nearest to the switchboard or the distribution board from which the feeder is supplied.

All interior communication circuits, in addition to the capital letter I have the designating letter of the circuit as marked in the list and on the wiring plans, using a small case letter thus: Admiral Calls, I-a; Warning Signals, I-q; Electric Log, I-y; etc., etc.

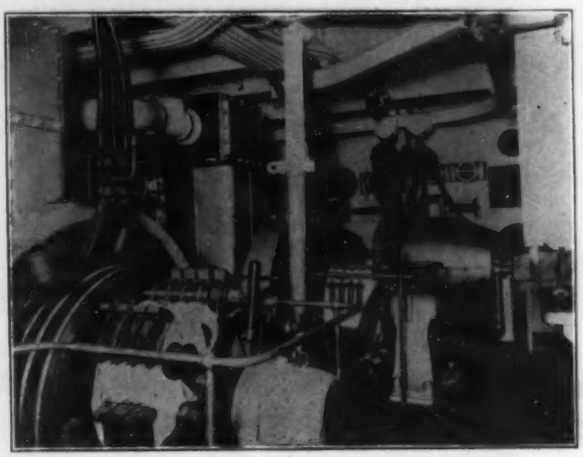
Where an interior communication lead contains wires for more than one circuit, the designating letters of all the circuits contained are listed, the order of the letters indicate the order of predominance of the several circuits: Thus a circuit carrying in the main voice tube calls, also some telephone talking wires, and one or two captain's calls, is marked I-e-j-a.

Each lead in all the compartments is tagged; a metal tag stamped as per above description is firmly secured to the conduit or voice pipe in a manner which permits the marking of the tag to be readily discerned; the tags may be seen on conduits above the switchboard in the illustration.

Generating Sets.

The electric generating plant consists of seven Union Iron Works generating sets, three being of 100 k. w. capacity; 800 amperes at 125 volts and 275 r. p. m., and four of 50 k w. capacity; 400 amperes at 125 volts and 350 r. p. m.

The three 100 k. w. and one of the 50 k. w. sets



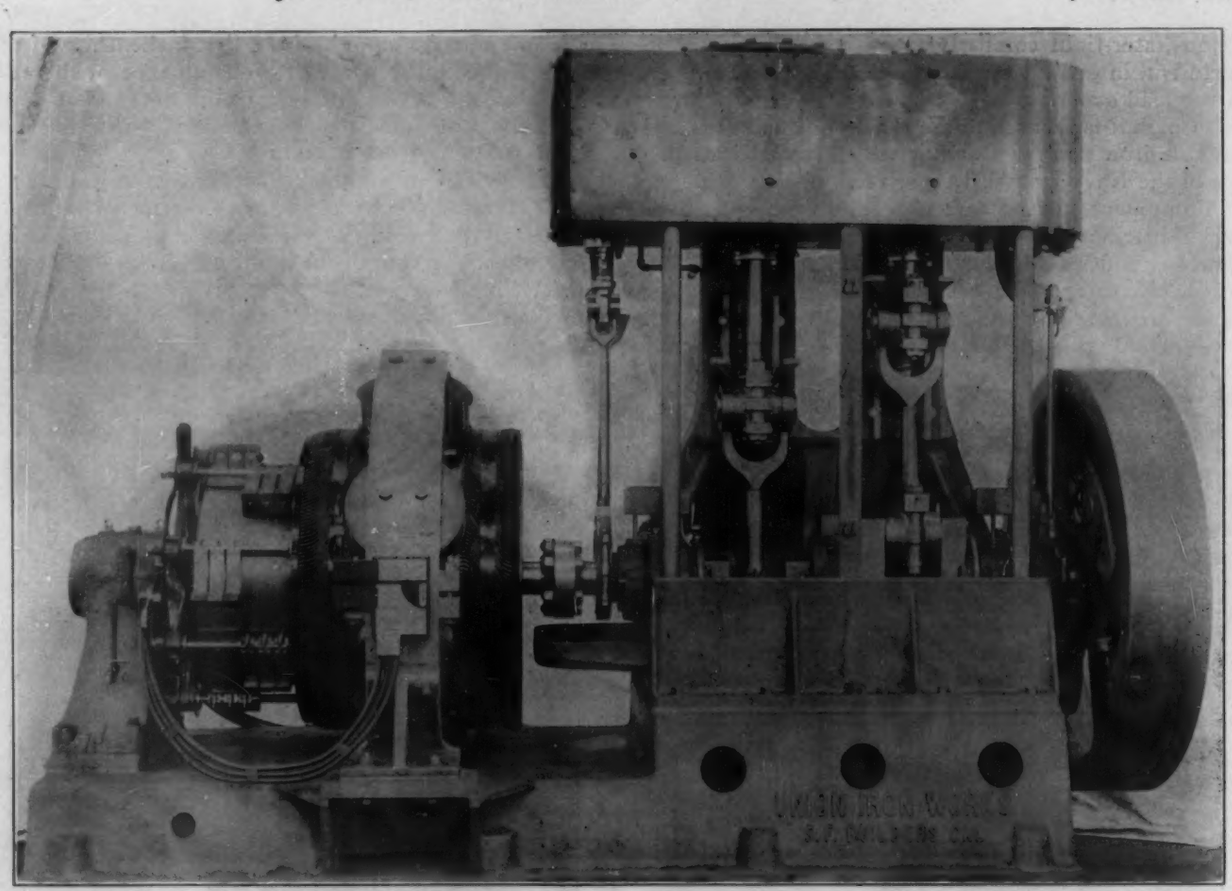
100 k. w. Sets in Lower Dynamo Room.

are located in the lower dynamo room; the other three 50 k. w. sets are located in the upper dynamo room along with the switchboard.

In each set, the engine and generator is mounted on a bed plate of oblong shape which is provided with recesses and is mounted on a foundation of teak wood. The bed plate is secured in place with bolts which pass through the foundation and deck. The nuts for the belts setting up against the bed plate in easily accessible locations. The bed plate and foundation are surrounded by a framing of angle iron secured to the deck and thus forming a waterway to receive waste oil and water.

The engines are of the double-acting, vertical, inverted cylinder, cross-compound type, designed to operate either condensing or non-condensing. They were designed to operate under the former condition with 100 lb. steam pressure, but, owing to changes in the specifications for generating sets, whereby the standard pressure has been increased from 100 to 150 lb., 125 lb. was selected as the normal working pressure for these engines.

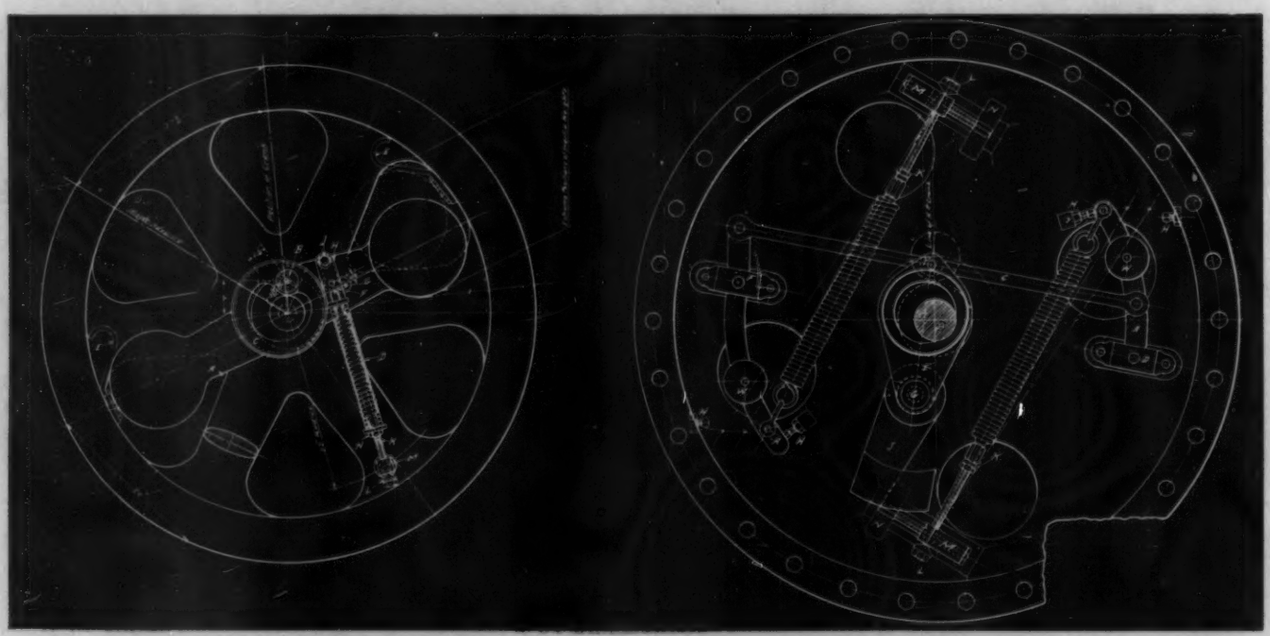
The operation at this pressure is satisfactory and the engines have been thoroughly tested to demonstrate their adaptability to pressures 20 per cent above and 20 per cent below the normal. The log of tests, which are given herein, shows the typical performance



100 k. w. Generating Set Showing Engine with Oil Guards Removed.

of each engine under all conditions imposed by the standard specifications of the Bureau of Equipment. The engines are of the open frame type, but are provided with all necessary oil guards.

The governor of the 50 k. w. engine is of the inertia type and is mounted in the fly wheel. The ideal conditions are attained when the load on the engine is steady and the pull of the springs is exactly balanced by the centrifugal force acting on the weights. Under these conditions any variation of load is taken care of by the governor without much change in the speed of the engine, as a difference of a few revolutions, fast or slow, will suffice to produce sufficient change in the valve-travel to compensate for a change



Rite's Inertia Governor.

Union Iron Works Inertia Governor.

of from full load to no load, and at the same time maintain a steady speed. The general arrangement of the governor is shown in accompanying figure.

The description of the 50 k. w. engine applies to the 100 k. w. engine, they being of the same general design and type, with the exception of the governor. The governor of this engine is of a very simple construction. It is known as the "Rite's" dumbbell governor, and is manufactured by the Union Iron Works under an agreement with the patentee. This governor can be adjusted so that it will make the engine run at the same speed with the full load or no load, or even several revolutions faster at full load than with the load off. As space will not permit, will not endeavor to discuss the characteristics of the governor further than to state that any further adjustments to increase the full load speed more than that shown in the regulation tests shown herein, has a tendency to cause unsteady speed or searching of the governor, owing to having reached the critical point of the governor springs.

The 50 k. w. generators are of the multipolar type, having six poles mounted in a circular field ring or yoke. They are compound wound and were designed for a constant potential of 125 volts at the terminals when running at 350 r. p. m. The full load current is 400 amperes. The armature which is of the simple type known as the "Gramme ring," and is slotted; the total number of slots being 108. The teeth are "T" shaped, the overhang of these teeth serving to retain in place the hardwood slot-wedges, which hold the armature conductors in place in the slots without the aid of binding wires. The armature connection employed is that commonly known as the "simplex ring" having parallel, singly-reentrant grouping of conductors. The conductors are connected in series all around the armature. As the machine has six poles and the same number of brush studs and sets of brushes, the winding is one of six paths.

This type of armature is without doubt one of the best for installations where repairs are made on board ship. The writer has seen several defective coils replaced in as many hours, without disturbing or removing the upper half of the field frame; the removal of engine oil guards only being necessary.

In the construction of the field coils, the shunt winding is wound directly over the series of compound winding; there are no series shunts; the total armature current passing through the series coils.

The 100 k. w. generators are also of the multi-pole type, have eight poles, are compound and were designed for a constant potential of 125 volts at the terminals when running 275 r. p. m.; the full load current is 800 amperes. The general design is the same as that of the 50 k. w. with the exception of the armatures and series field coils. The armature coils number 240, they are form wound and the winding is the "simplex lap winding," in which the end of each coil situated in fields of opposite polarity, is connected through a commutator segment to the beginning of a coil lying within the arc embraced by the former. With reference to the direction of connecting, the beginning of every following coil lies back of the end of the foregoing, thus the winding forms a series of loops which overlap each other.

The armature coils are held in place by means of hard bronze wire bands; four are spaced across the core proper, and two each embrace the front and back heads respectively; there is also a wide cotton cord band over the leads where they join the commutator. The field coils differ from the 50 k. w. only in respect to the series coils, to the terminals of which german silver shunts are attached; they are located on the back of the terminal boards.

Tests.

In concluding this article the writer wishes to call attention to the method in which the tests of the generator sets were conducted. As space will not permit, only the log sheets and plotted curves of one of the generating sets has been given. As the generators and engines are practically of the same type, the tests of the generating set No. 1, which is of 100 k. w. capacity may be considered as typical of the performance of each of the other generating sets.

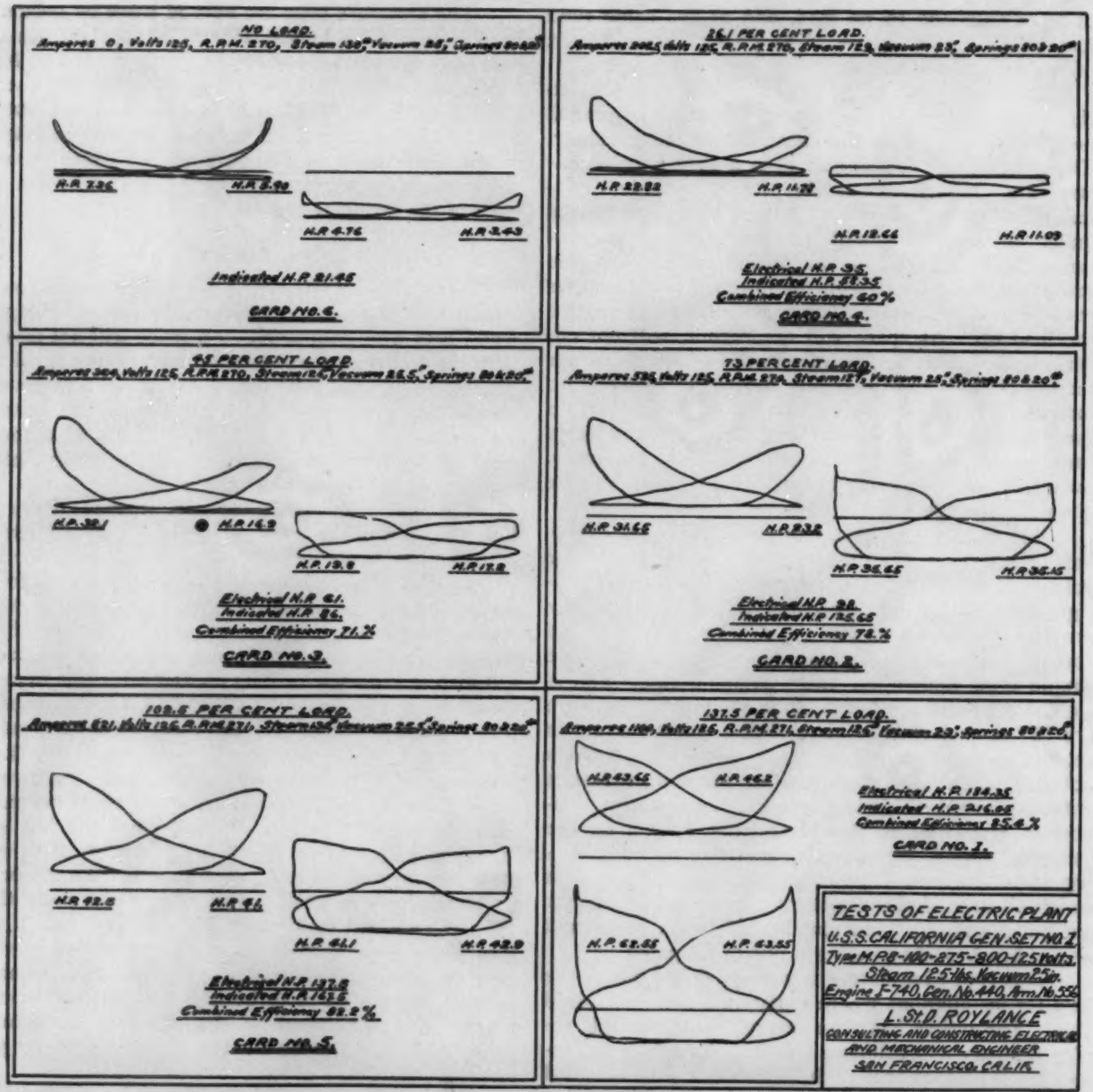
The log sheet shows the performance of the set from the start of the test with 1/3 overload, continuing with various loads and ending with full load for the last six hours of the test. In reference to the compounding test, the potential variation allowed is 2 per cent or 2½ volts above or below 125 volts, and the jump in voltage must not exceed 15 per cent when the full load is suddenly thrown on and off. The requirements for engine regulation are that the speed variation must not exceed 2½ per cent when the load is varied between full load to 20 per cent of full load, gradually or in one step, engine running with normal steam pressure and vacuum. A variation of not more than 3½ per cent will be allowed when the full load is suddenly thrown on or off the generator, with constant steam pressure and vacuum, either normal or 20 per cent above normal; a variation of not more than 3½ per cent will be allowed when 90 per cent of full load is suddenly thrown on or off the generator with constant steam pressure at 20 per cent below normal; exhaust in both cases to be into condenser or atmosphere. No adjustment of the governor or throttle valve is allowed during the test to insure proper performance under any of the above conditions.

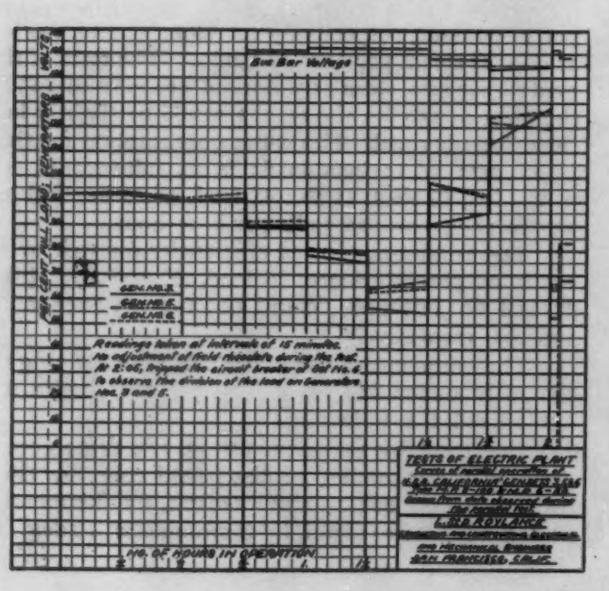
The water consumption allowed for the generating sets at full load, is not to exceed 35 and 31 lbs. per k. w. hour, respectively for 50 k. w. and 100 k. w. at normal steam pressure of 150 lbs. The tests of these generating sets were at a normal pressure of 125 lbs., therefore at 150 lbs. the results would be slightly lower than that obtained. The water consumption for the 50 k. w. sets at various loads is as follows: ¼ load, 57.751 lb.; ½ load, 41 lb.; ¾ load, 36.20 lb.; full load, 33.5 lb.; 1/3 overload 32 lb. per k. w. hour.

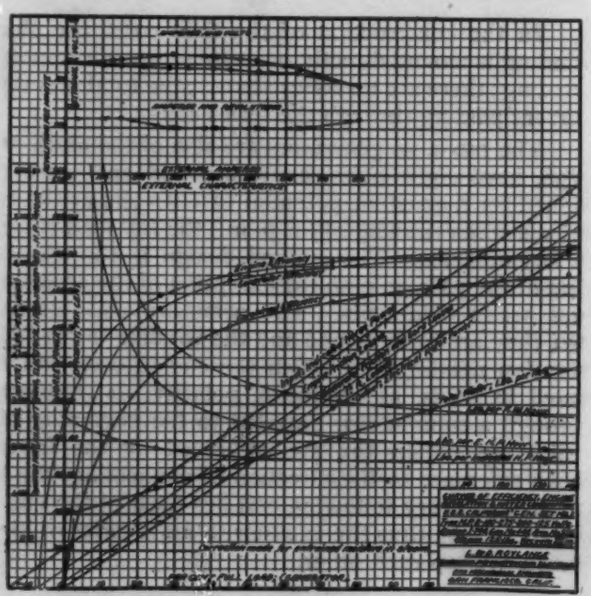
The minimum allowed efficiencies for 50 k. w. and 100 k. w. generators are: ½ load, .86 and .87; ¾ load, .88 and .89; full load, .89 and .90; and 1/3 overload, .89 and .90, respectively.

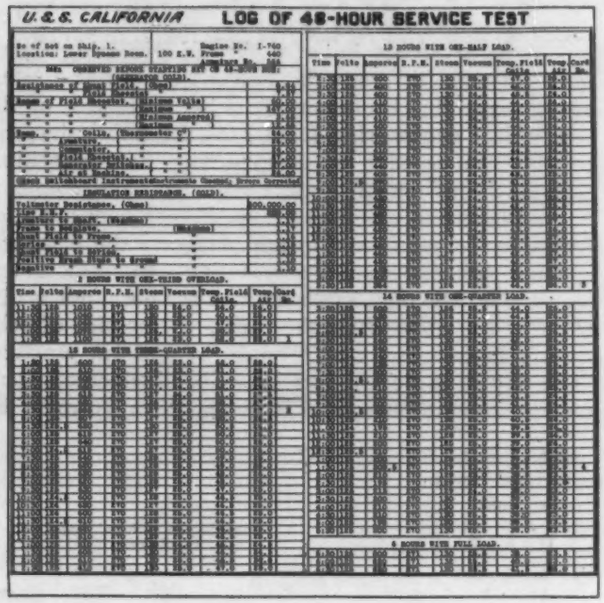
The temperature rise of the sets after running continuously under full rated load for four hours must not exceed the following:

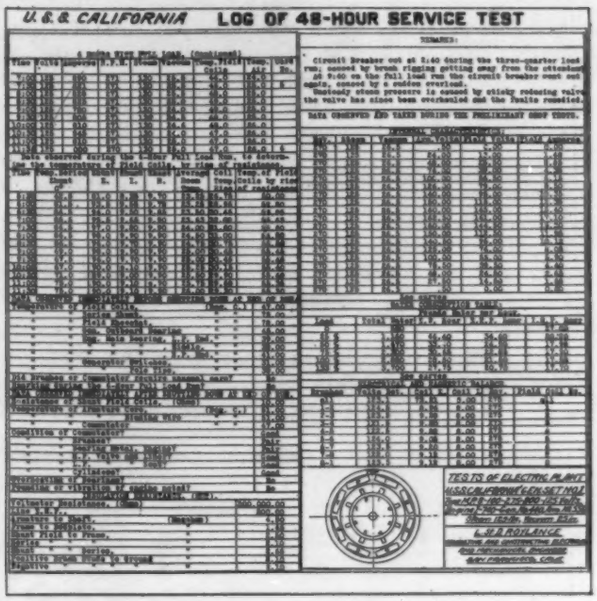
Armature by thermometer 33 1/3 deg.; commutator by thermometer, 40 deg.; field coils, by rise of resistance 33½ deg.; shunt rheostat, by thermometer, 75 deg.; and series shunt, by thermometer, 40 deg. The


NO LOAD.
H.P. 7.26
H.P. 8.90
H.P. 4.76
H.P. 3.43
Indicated H.P. 21.45
CARD NO. 6.
26.1 PER CENT LOAD.
H.P. 22.82
H.P. 14.79
H.P. 12.66
H.P. 11.09
Electrical H.P. 35.
Indicated H.P. 58.55
Combined Efficiency 60%
CARD NO. 4.
48 PER CENT LOAD.
H.P. 38.1
H.P. 16.9
H.P. 13.9
H.P. 17.8
Electrical H.P. 61.
Indicated H.P. 84.
Combined Efficiency 71.%
CARD NO. 3.
73 PER CENT LOAD.
H.P. 34.65
H.P. 23.2
H.P. 36.65
H.P. 35.15
Electrical H.P. 98.
Indicated H.P. 135.65
Combined Efficiency 78.%
CARD NO. 2.
103.5 PER CENT LOAD.
H.P. 42.6
H.P. 41.
H.P. 41.1
H.P. 42.9
Electrical H.P. 137.6
Indicated H.P. 165.6
Combined Efficiency 83.2%
CARD NO. 5.
137.5 PER CENT LOAD.
H.P. 43.65
H.P. 46.2
Electrical H.P. 194.35
Indicated H.P. 216.05
Combined Efficiency 85.6%
CARD NO. 1.
H.P. 63.65
H.P. 63.55
TESTS OF ELECTRIC PLANT
U.S.S. CALIFORNIA GEN. SET NO. 1
Type M.R.B.-100-275-800-12.5 Volts.
Steam 12.5 lbs. Vacuum 25in.
Engine F-740, Gen. No. 440, Arm. No. 556
L. St. D. ROYLANCE
CONSULTING AND CONSTRUCTING ELECTRICAL AND MECHANICAL ENGINEER
SAN FRANCISCO, CALIF.


Bus Bar Voltage
GEN NO. 3
GEN NO. 5
GEN NO. 6
Readings taken at intervals of 15 minutes.
No adjustment of field rheostats during the test.
At 2:05, tripped the circuit breaker of Gen No. 6.
To observe the division of the load on generators
nos. 3 and 5.
TESTS OF ELECTRIC PLANT
L. St. D. ROYLANCE
SAN FRANCISCO, CALIF.
NO. OF HOURS IN OPERATION


L. St. D. ROYLANCE
SAN FRANCISCO, CALIF.


U.S.S. CALIFORNIA LOG OF 48-HOUR SERVICE TEST


U.S.S. CALIFORNIA LOG OF 48-HOUR SERVICE TEST

rise of temperature to be referred to a standard room temperature of 25 deg. C. and normal conditions of ventilation.

The generators must be capable of operating for a period of two hours carrying one and one-third times its rated full load, and no part shall heat to such a degree as to injure the insulation. Generators of same size and manufacture must be capable of operating in parallel, the division of the load to be within 20 per cent throughout the range. The magnetic leakage at full load shall be imperceptible at a horizontal distance of 15 feet.

On the completion of the vessel and before acceptance, the insulation resistance of all circuits is tested out and must conform to the following specifications: Circuits must be connected up to all their outlets and show an insulation resistance of not less than 1 megohm between circuits, and from each circuit to ground. Searchlight feeders and motor feeders must show an insulation resistance of not less than 5 megohms, the circuits not being connected up.

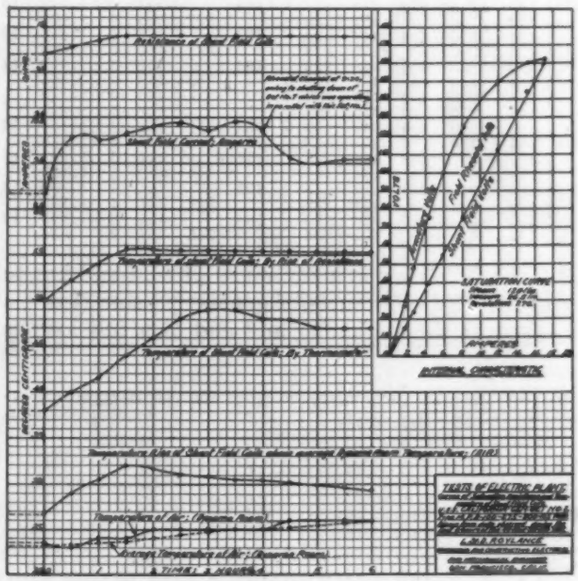
A pressure of 125 volts is used for measuring the insulation resistance of all circuits which operate at the dynamo voltage. Interior communication circuits not included in the above are tested by means of a standard portable testing set.

The generating sets, wiring appliances, fixtures, accessories, etc., must pass tests required by their respective specifications. The generating set specifications are somewhat varied and exacting. The sets on completion are given thorough shop tests, and after being installed and before acceptance on completion of the vessel, they are again subjected to a 48-hour service test.

The following log sheets with curves, etc., includes test data observed during the preliminary shop tests and which was not again observed during the 48-hour service test on board the ship. The test herein shown is of generating set No. 1 which is of 100 k. w. capacity and is typical of tests of the other 50 and 100 k. w. generating sets.

The tests were started and continued without intermission until completed. The loads were obtained from the ship's installation of incandescent lamps, ventilation and power motors, and also by water rheostate located on the dock.

All data and observations were recorded in the log sheets as shown in the various figures.



Sets Nos. 1 and 2 were taken as types of their respective sizes (50 and 100 k. w.), and data which is considered of interest and which was observed during the perliminary shop tests, has been embodied and curves plotted. During the 6-hour full load run, data was observed and taken to ascertain the maximum heating of the field coils, when subjected continuously to normal current; it being questioned at the time whether the coils had reached their maximum temperature at the end of the 4-hour heat run. Curves plotted from the data are shown. On the log

sheet tables are shown of internal characteristic; electrical and magnetic balance and water consumption; and curves of water consumption and internal characteristic plotted from same are also shown in the accompanying figures.

Indicator diagrams taken during the test and efficiency curves plotted from same are shown, together with curves of compounding and revolutions. The efficiency curves of the set show the engine, generator and combined efficiencies. Curves of parallel operation of three generating sets likewise appear herewith .

The engine regulation tests under various load, steam and exhaust conditions for generating sets Nos. 1 and 4, being 50 and 100 k. w. respectively, follows:

THE SALESMAN'S CREED.

The November issue of the "Engineering Quarterly" of the University of Missouri contains an interesting paper by Professor H. Wade Hibbard, of the mechanical engineering faculty of the university, entitled "The Science of Engineering Salesmanship." After a discussion of modern industrial and commercial methods the writer takes up the personal qualities desirable for salesmanship and analyzes the elements which enter into a sales transaction. Manufacturers, it is stated, who once said salesmen are born, not made, are now beginning to make them. Principles of selling are investigated and brought to uniform practice. "The day of the crafty, tricky, glib, ill-educated, loud and intemperate salesman is gone. Now he must be

U. S. S. CALIFORNIA—LOG OF 48-HOUR SERVICE TEST.

DYNAMO ENGINE REGULATION TESTS.

Set No.	Steam	Vacuum	Amperes	Rev.	Volts	Jump Revolutions High	Jump Revolutions Low	Jump Revolutions Steady	Jump Revolutions Change	Jump Revolutions % Change	Jump Volts High	Jump Volts Low	Jump Volts Steady	Jump Volts Change	Jump Volts % Change	Load, Steam and Exhaust Conditions
1.	100	21.5	800	273	125	282		271	2	.732	137		127	12	9.60	Full load to no load, 100 lbs. steam, vacuum exhaust.
	100	21.5	0	271	127		263	273	2	.738		115	125	12	9.45	
	125	22.0	800	271	125	282		270	1	.369	140		127	15	12.00	Full load to no load, 125 lbs. steam, vacuum exhaust.
	125	22.0	0	270	127		264	271	1	.370		118	126	9	7.10	
	150	21.5	800	271	125	284		273	2	.738	139		130	14	11.20	Full load to no load, 150 lbs. steam, vacuum exhaust.
	150	21.5	0	273	130		262	271	2	.732		117	123.5	13	10.00	
	127	22.5	800	271	125			270	1	.369			126	1	.80	Full load to 20% full load, gradually, 125 lbs. steam, vacuum exhaust.
	127	22.5	170	270	126			271	1	.370			122.5	3.5	2.78	
	125	23.0	800	272	125	280		271	1	.368	139		129	14	11.20	Full load to 20% full load, one step, 125 lbs. steam, vacuum exhaust.
	125	23.0	170	271	129		264	272	1	.369		120	124	9	6.98	
	100	0.	720	276	125	282		274	2	.725	138		129	13	10.40	90% full load to no load, 100 lbs. steam, atmosphere exhaust.
	100	0.	0	274	129		265	276	2	.730		118	125	11	8.54	
	125	0.	800	276	125	284		274	2	.725	140		130	15	12.00	Full load to no load, 125 lbs. steam, atmosphere exhaust.
	125	0.	0	274	130		265	276	2	.730		119	126	11	8.47	
	150	0.	800	277	125	282		274	3	1.080	141		129.5	16	12.80	Full load to no load, 150 lbs. steam, atmosphere exhaust.
	150	0.	0	274	129.5		265	277	3	1.095		118	125	11.5	8.88	
4.	100	21.5	400	346	124.5	353		351	5	1.440	132		128	13.5	10.85	Full load to no load, 100 lbs. steam, vacuum exhaust.
	100	21.5	0	351	128		343	346	5	1.420		120	124.5	8	6.25	
	125	22.0	400	347	123	353		352	5	1.440	132		125	9	7.32	Full load to no load, 125 lbs. steam, vacuum exhaust.
	125	22.0	0	352	125		342	347	5	1.420		117	123	8	6.40	
	150	21.5	400	348	125	354		351	3	.862	131		127.5	6	4.80	Full load to no load, 150 lbs. steam, vacuum exhaust.
	150	21.5	0	351	127.5		342	348	3	.855		121	126	6.5	5.10	
	125	22.5	400	347	122.5			352	5	1.440			124	1.5	1.22	Full load to 20% full load, gradually, 125 lbs. steam, vacuum exhaust.
	125	22.5	80	352	124			347	5	1.420			122.5	1.5	1.21	
	125	23.0	400	347	123.5	353		351	4	1.150	129		126	2.5	2.02	Full load to 20% full load, one step, 125 lbs. steam, vacuum exhaust.
	125	23.0	80	351	126		344	347	4	1.140		120	123.5	6	4.76	
	100	0.	360	346	125	352		351	5	1.440	134		130	9	7.20	90% full load to no load, 100 lbs. steam, atmosphere exhaust.
	100	0.	0	351	130		342	346	5	1.420		122	125	8	6.15	
	125	0	400	347	125	353		351	4	1.150	134		129	9	7.20	Full load to no load, 125 lbs. steam, atmosphere exhaust.
	125	0.	0	351	129		344	347	4	1.140		120	125	9	6.98	
	150	0.	400	348	125	354		351	3	.862	134		126	1	.80	Full load to no load, 150 lbs. steam, atmosphere exhaust.
	150	0.	0	351	126		345	348	3	.855		118	125	8	6.35	

The following is a summary of cold and hot temperatures and resistances of generating sets Nos. 1 and 4, taken at the beginning and end of a full load heat test:

TEMPERATURE AND RESISTANCE OF GENERATING SETS.

GENERATOR NUMBER.	1		4	
TEMPERATURES.	C	H	C	H
Armature	20.	54.	23.	55.
Commutator	20.	52.	23.	54.
Shunt Field Coils	20.	50.5	23.	44.
Series Field Coils	20.	50.5	23.	44.
Series Shunt	20.	68.5	....	...
Field Rheostat	24.	57.	25.	66.
Generator Switches	21.5	29.	26.	32.5
Generator Pole Tips	20.	42.	23.	45.
Generator Outboard Bearing	20.	44.	23.	44.
Engine Main Bearing, L. P. end	20.	38.	23.	47.
Engine Main Bearing, Middle	20.	42.	...	...
Engine Main Bearing, H. P. end	20.	42.	23.	43.
Air at Machine	20.	26.5	23.	28.
RESISTANCE.				
Armature	.00448	.005035	.00567	.00634
Shunt Field Coils	8.74	10.15	7.88	8.56
Series Field Coils	.000748	.000838	.000925	.00100
Field Rheostat	9.65	.....	26.8	.....

NOTE—C: Cold Resistance observed before starting test.
H: Hot Resistance observed at end of full load run.

honest and have a reputation for honesty, be an expert in evidence, a trained logician, well educated and able to meet his customers on their own ground, of good health that his mind may be alert, and personally attractive, acquainted with the practical physiology of typical customers, able to give proofs so pointedly that the purchaser can be brought quickly to the closing of the sale." The paper concludes with the following "Salesman's Creed":

"I believe in the goods I am selling, in the firm I am working for, and in my ability to get 'results.'

"I believe that honest goods can be sold to honest men by honest methods.

"I believe in working, not exacting; in laughing, not weeping; in boosting, not knocking, and in the pleasure of selling goods.

"I believe that a man gets what he goes after; that one order to-day is worth two orders to-morrow, and that no man is down-and-out until he has lost faith in himself.

"I believe in courtesy, in kindness, in generosity, in good cheer, in friendship and honest competition.

"I believe there is an order somewhere for every man ready to take one.

"I believe I am ready—right now."

DISCUSSION

THE MULTIPLE ARCH DAM.

To the Editor:—In the Journal of Electricity, Power & Gas for December 25, '09, Mr. C. E. Grunsky, in commenting upon a dam built by Mr. J. S. Eastwood near Hume, Fresno County, California, states that the most economical arch is one which covers 60 degrees. This the writer fails to see.

The most economical arch would have a triangular cross section with maximum width at the foundation and zero width at the water surface. The amount of concrete in any arch is:

Area of cross section x 2 x mean radius x enclosed angle. We will have minimum of material when

$$\frac{\text{d. Amount of concrete}}{\text{d. Enclosed angle}} = 0$$

By differentiating it can be shown, that this equation is satisfied, when the enclosed angle is 133° 34'.

As the top width of the dam cannot be zero, this angle will for a practical profile fall out somewhat smaller in the neighborhood of 120° as Mr. Eastwood has it. In short spans, however, it may very well be possible that the enclosed angle can be made smaller than 120° for maximum economy, but for special reasons.

A certain minimum thickness is always required for water-tightness and if the concrete has to be there it might just as well be loaded. Doubling the length of the radius, throws twice the strain on the concrete for the same span and cuts the enclosed angle nearly in half. Therefore if the concrete can stand the additional load it is economy to make the radius larger, thereby the enclosed angle smaller, but this is only a special case, the rule is that the enclosed angle has to be near 120° for maximum economy of material.

LARS JORGENSEN.

To the Editor: The idea of forming a masonry dam of a number of piers between which vertical arches convex upstream are sprung is not new. About 1800 such a dam was built in India to form the Meer Allum reservoir. This dam, which forms in plan a large arch about half a mile long, consists of 21 smaller arches which transmit the water pressure to solid-masonry buttresses. The greatest depth of water in this reservoir is about 50 feet. About 1898 a similar dam, having a maximum height of about 60 feet, was built across the Belubula River in New South Wales, to form a storage reservoir. Short descriptions of both of these dams are given in the fifth edition of my book on the "Design and Construction of Dams."

In preparing plans for a concrete dam at Ogden, Utah, which was to be 369 feet long and 105 feet high above the foundation, Henry Goldmark, M. Am. Soc. C. E., proposed to make the structure consist of piers 16 feet wide, placed 32 feet apart in the clear, which were to support inclined segmental arches. (See Trans. Amer. Soc. C. E. for December, 1897.)

Mr. George L. Dillman, M. Am. Soc. C. E., demonstrated mathematically, that a saving in material may be effected by building a dam of piers and arches (see his paper on "A proposed New Type of Masonry Dam" in Trans. Am. Soc. C. E., for December, 1902).

A few years ago I was asked to make calculations for a dam 160 feet high, of the type described above, viz.: piers joined by vertical arches. While I found that a saving of about 15 per cent might be effected by this construction, as compared with the usual uniform wall, adopted for a dam, I had some doubts as to how such a structure could be kept water-tight under a head of 160 feet, without going to too great an expense. The project was never carried out as the necessary means could not be secured.

A style of dam of the same order is the reinforced concrete dams, which are being built by the Ambursen Hydraulic Construction Company of Boston, Mass. These dams are made of buttresses, placed 12 to 15 feet apart, which are joined by a water-tight deck.

Mr. Eastwood gives a very interesting description of the first dam in the United States, so far as I know, that has been built of piers joined by vertical arches. I feel satisfied that some saving in material (probably 10 to 15 per cent), may result from adopting this type of dam, instead of the usual uniform wall, and more structures of this kind are likely to be built hereafter.

Whether this plan should be adopted for a high masonry dam is a question about which I do not feel quite sure, as the saving in masonry might be offset by the additional cost required to secure water-tightness.

E. WEGMANN.

CIRCULATION AND ADVERTISING CONTRACT MEETING OF TECHNICAL PUBLICITY ASSOCIATION.

The Technical Publicity Association held its December meeting on Thursday, the 9th, at the National Arts Club, No. 14 Gramercy Park, New York. After the usual informal dinner a lively discussion ensued over the subject of Circulation and the introduction of the proposed uniform advertising contract for trade papers. Mr. F. H. Gale, charge of advertising for the General Electric Company, Schenectady, N. Y., took his turn at presiding during the debate. The attendance was large, and the participation in the discussion of the prominent technical advertising men and trade paper publishers who were present made the session a most profitable one.

William H. Taylor, treasurer and manager of the Iron Age, opened the discussion, giving it as his opinion that the true measure of a publication is its editorial quality. He said there was no more discriminating class of people in existence than subscribers to a publication.

Mr. Taylor said that advertisers should put themselves in the proper frame of mind in approaching the circulation question. He granted their perfect right to know how many and who read a publication, and he said no good publication refuses such information. The trouble has been, he said, not that the publishers have been ashamed of their circulation, but that wrong deductions may be made when a reputable publisher's statement is placed in comparison with an untruthful one. Mr. Taylor made the first public announcement of the circulation of the Iron Age.

C. S. Redfield, advertising manager Yale & Towne Mfg. Company, and president of the T. P. A. here explained how members considered the circulation statements of publishers, being in some cases absolute sworn statements, also the possibility of detecting the liars.

John McGhie of the American Machinist, told about the passing of old-time advertising solicitation in which the hypnotic eye played a prominent part, and said that after trying all other policies, publishers have learned that the truthful policy is the best. He said the advertiser buys reputation and editorial force quite as much as circulation.

F. R. Davis, of the General Electric Company, said that many publishers seemed to feel that advertising men know their own business, and tried to lead them into unprofitable contracts.

H. M. Sweatland, publisher of Automobile, said it was his purpose as a publisher to furnish maximum quantity, but that for a class paper to go beyond a certain quantity was simply to vitiate itself. A phenomenal solicitor, he said, once got a thousand subscriptions within a radius of 20 miles, but after two years only one more subscriber was on the list for that district than there was prior to his solicitation.

JOURNAL OF ELECTRICITY
POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

FOUNDED 1897 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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With this, the initial issue of 1910, which appears on New Year's Day, we take pleasure in wishing all our readers a "Happy New Year." From the many words of commendation received, we believe that our efforts during 1909, to make a bright and readable technical journal, recording the power progress of the West, have not been in vain. During the past year nearly twelve hundred pages of editorial matter have been published, the greater part of which appeared herein before it was published elsewhere. For the fifty-three numbers of 1910 many interesting and valuable articles are assured.

Hydrogen

The fledgling science of aeronautics is demanding cheaper hydrogen gas for the dirigible balloon. Hydrogen has more than seven times the lifting power of an equal volume of illuminating gas, which is often used for this purpose, as it is about one-half as heavy as air. But processes giving hydrogen as a waste product are few and far between. The action of sulphuric acid on iron is expensive, as the resulting bluestone is more cheaply produced by other methods. Electrolytic dissociation of water is used to advantage where the oxygen can also be utilized, as in the recent perfected process for cutting and welding metals by means of the oxygen and hydrogen blow-pipe. A company in Germany has recently perfected a process whereby it is proposed to furnish hydrogen at a cost of one dollar per thousand feet. This process involves the reaction between water gas and calcium carbide, when the latter is highly heated. All the constituents of the water gas, except the hydrogen, unite to form solid compounds, which allow practically pure hydrogen to be conducted to the holder. Thus has aviation brought new work to the electric furnace, in which is made the calcium carbide.

Electricity on a Man-of-War

There is no change in methods of warfare which has been more radical than that which has been quietly and unobtrusively wrought by electricity within the past decade. There is hardly a phase of the military art to which it has not been applied. Its many varied uses have become as indispensable in the army and navy as in our industrial and domestic lives. Imagine the great guns on our battleships and in our coast defenses being moved by hand-power, and their ammunition supplied by powder boys; note the helplessness of a battleship without searchlights; make communication as difficult and slow as it was before the invention of the telegraph and the telephone—and we would soon realize our dependence upon electricity for fighting. In facilitating means for warfare, electricity has done more to promote peace than all the congresses yet convened.

Nevertheless, there are few people who understand how and where it is used on board a man-of-war. We consequently feel justified in devoting the major portion of this issue to a detailed description of the electrical installation of an armored cruiser.

As will be noted, the present naval practice is to generate direct current at 125 volts and distribute on the two-wire system, current thus being supplied for lighting, power and communication. Aside from the tests of the generating machines, perhaps the most interesting part of the paper is its description of the various power applications, and their control. Of these, the most exacting requirements are those of the gear for revolving the gun turrets. When it is understood that these must be able to revolve uniformly at the rate of but one revolution for twenty-four hours, with seventy intermediate speeds between that and one revolution in three and one-half minutes, it is easy to comprehend the difficulties of applying electric power to this service, especially when the turret must be brought to full speed within ten seconds and stopped within five seconds.

PERSONALS.

Walter G. Niles of the Reierson Machinery Company of Portland, Oregon, is in San Francisco.

Joseph T. Wolfe, electrical engineer for the Tonopah Mining Company, was in San Francisco this week.

R. F. Oaks, president of the American Ever-Ready Company, left last Thursday on an extended trip to New York.

Charles F. Clayton, general superintendent of the Tuolumne Transmission Company, was in San Francisco this week.

W. J. Davis Jr., Pacific Coast engineer for the General Electric Company, left San Francisco on December 29th for the South.

W. J. Sussex of Wenatchee, Washington, has been made local consulting engineer for Fairbanks, Morse & Company at Seattle.

E. H. Corbett has offices in the Commercial Club Building, Portland, Oregon, with a complete line of gas appliances and gas works equipment.

E. A. Quinn has resigned as general superintendent for the Nevada-California Power Company at Goldfield, and will probably locate in San Francisco.

George Scarfe, superintendent of the Nevada district of the Pacific Gas & Electric Company, recently became a grandfather at the early age of forty-two.

H. R. Noack, manager of Pierson, Roeding & Co. addressed the Los Angeles Section, A. I. E. E. on "Aging of Insulators," on December 28, 1909.

H. W. Beecher, manager of the Seattle office of Chas. C. Moore &Co., Engineers, Inc., returned to Seattle this week after a brief stay in San Francisco.

F. V. T. Lee, assistant general manager of the San Francisco Gas & Electric Company, will return from an extended vacation to the Antipodes early next week.

P. F. Lane and W. H. Warren, formerly with the Pacific Telephone & Telegraph Company, have established the Southern Oregon Electric Company with headquarters at Medford, Oregon.

J. A. Herr, formerly with the Philadelphia and New York offices of the Sprague Electric Company, has joined the San Francisco offices of this company as specialist on flexible steel conduit and steel armored conductors.

John A. Britton, vice president and general manager of the San Francisco Gas & Electric Company, was recently chosen one of the committee of two hundred, to develop and finance the Panama Exposition to be held in San Francisco in 1915.

John Carter, chief engineer of the Crocker building, was presented last Tuesday with a silver dinner set by some of his friends among the stationary engineers of San Francisco in recognition of his good fellowship amongst his brother engineers.

P. M. Haight, well known in electrical circles as treasurer of the Sprague Electric Company, was recently elected president of the Electrical Trades Society of New York. Mr. Haight's experience in this line combined with enthusiastic ability bespeaks for the society a successful administration.

George A. White of the contracting engineering firm of White & Newcomb, Mexico City, is spending the Christmas holidays in San Jose. The firm of White & Newcomb has the contract for installing the plant of the celebrated Santa Gertrudas y Guadalupe Company at Pachuca, Mexico, besides many other plants of importance in the southern republic.

NEWS NOTES.

The Union Lumber Company of Fort Bragg are figuring on a 750 k. w. turbine.

Keeler, White & Co., on December 28th, shipped a complete wireless equipment, good for 500 miles, to Tahiti.

The Western Distillery at Agnews, Cal., ordered from the Western Electric Company, 75 k. w., Hawthorn d. c., engine type generator, with motor equipment and switchboard.

The General Electric Company recently shipped a 500 h. p Curtis turbine to the Honolulu Iron Works, to be installed by them for the Honolulu Plantation Company. The turbine is to be direct connected with a Byron Jackson pump.

Chas. C. Moore & Co., Inc., engineers, report the sale through their Seattle office of a 6000 h. p. steam plant to the British Columbia Electric Co. This is to be installed at Vancouver as an auxiliary to the hydroelectric plant of the company. Allis-Chalmers have the contract for the turbines, Chas. C. Moore & Co. supplying the boilers and all auxiliaries.

The Chas. L. Kiewart Co. of San Francisco recently installed for the Haight Street and Ashbury Heights Improvement Club, four flaming arc lamps, two Aurola and two Alba. The lamps were put in on trial on Haight street between Masonic avenue and the Park. They have proven highly satisfactory and the improvement club will immediately install 40 lamps in this district , putting eight lamps to a block.

The Holabird-Reynolds Company of San Francisco, Holabird-Reynolds Electric Company of Los Angeles and Holabird Electric Company of Seattle have been duly appointed as the Ohio Brass Company's exclusive sales agents for O-B Hi-Tension Porcelain Insulators in the States of California, Oregon and Washington. Pierson, Roeding & Company, with offices at San Francisco, Los Angeles and Seattle, will continue to be exclusive sales agents for overhead material, rail bonds, car equipment specialties and catenary material, including such special porcelain insulators as are used in catenary construction.

The Board of Public Works of Spokane, Wash., recently awarded a contract to the Allis-Chalmers Company of Milwaukee for the new municipal waterworks pumping station. This company is the same one which built the New York high pressure fire protection service and is now building a pumping plant for Niagara Falls. The equipment will consist of six single suction, horizontal shaft, two-stage centrifugal pumps driven by three 900 h. p., 2200 volt, 60 cycle, 3 phase induction motors. Ordinarily the pumps will operate in parallel, but for fire pressure they will be connected two in series. The pumps will have a 24-hour capacity per pair of 7,500,000 gallons against 430 feet head or 12,000,000 gallons against 260 feet. A three panel switchboard will carry the controlling apparatus.

The Whatcom County Railway & Light Company have under course of construction in the Pelton Water Wheel Company's San Francisco shops, a multiple wheel Pelton impulse unit of unique design, inasmuch as the wheel unit is to develop 3200 h. p. under a head of only 165 ft. The wheel unit direct connects to an electric generator running 200 r. p. m. Under these conditions six impulse runners are employed on one shaft, each runner being supplied with water through a double nozzle. Ultimately the head will be increased to 400 ft., at which time, four of the runners will be taken from the wheel unit, leaving it a twin runner equipment when it is still to develop 3200 h. p. By reason of the great difference in pressure under which the wheel will temporarily and ultimately operate, the unit is of particular interest and design. It replaces an Eastern-made turbine. The water at this plant is particularly gritty, rendering the life of the existing turbine equipment short. The current from this power station will be transmitted to Bellingham and the surrounding towns.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

SAN FRANCISCO NO. 1.

Number 1 was favored with a visit from Bro. Waring of Fresno No. 7, who made some favorable remarks. The educational committee was granted power to provide a series of lectures on various engineering appliances from the many firms who desire to send their representatives to our meetings to exhibit their goods and endeavor to explain the merits of same, which no doubt will prove very instructive and interesting. L. H. Honigbaum, P. G. Burns, and Chas. Bankey submitted problems for discussion before the members present. On Tuesday evening, December 14th, the N. A. S. E. Club of San Francisco, gave a theater party at the Orpheum Theater. Seats were reserved in the front row of the balcony, after enjoying the performance the members repaired to an adjoining cafe, where refreshments were served and story telling and speeches were in order. At the next meeting of the club, which will be held on Tuesday evening, January 11th, business only will be transacted. P. L. Ennor is president, Chas. Dick is treasurer and H. W. Noethig is secretary, 816 York street.

PRACTICAL MECHANICS.

In a recent issue of the Journal it was announced that a series of papers would be given in this department covering some subject of importance of interest to mechanical or steam engineers. The subject first to be presented is indicated by the title of this article. In considering the broad field embraced by the science of mechanics as applied to machines it is difficult to make a selection which may be best suited to the individual needs of a majority of our mechanical department readers. After some deliberation, however, it has been decided to take up the various principles of mechanism involved in simple machines, and then to consider the application of these principles in the mechanics of the steam engine; this example being probably the most familiar and its study the most valuable to the steam engineer. In working out the design, drawing and specifications for a required machine definite factors have to be completely determined. First the form, which factor is governed by the work the machine is intended to do and by the external limitation imposed upon it; Second, the strength, a factor involving knowledge of the strength of materials and their wearing features; and third, the motions of the various parts. It is with this factor of motion that the principles of mechanism have to do.

The principles of mechanism are in reality the application of principles of kinematics—that branch of mechanics which deals with motion without reference to the cause producing it; several elementary combinations of mechanism sometimes being involved.

A machine may be defined as a combination of fixed and moving parts or devices so disposed and connected as to transmit or modify force and motion to the end that some useful result may be secured. The fixed parts constitute the frame or supports for the moving parts. The moving parts constitute a train or trains of mechanism.

A train of mechanism may be primary or secondary; the former being supported directly by the frame, and the latter by other moving parts.

All the moving parts may be regarded as mechanical devices and classified as follows:

First—Revolving shafts.

Second—Revolving wheels or cams with or without teeth.

Third—Rods or bars with reciprocating or vibrating motion or both.

Fourth—Flexible connectors depending upon friction.

Fifth—Flexible connectors independent of friction.

Sixth—A column of fluid in a pipe.

Trains of mechanism consist of combinations of the above devices. The least number of such combinations necessary to secure a desired modification of force or motion in a given case, is called an elementary combination.

A thorough systematic and comprehensive table of these elementary combinations was first arranged by Professor Robert Willis of Cambridge, England, and it is here given in full as the best means of showing the scope of our work.

In general then this will constitute our scheme of progress although certain digressions will be made from this fixed order of considering the topics, and where advisable in cases of more common application as e. g. gearing, belting, etc., the investigation will be made more complete than in the less useful combinations. For certain reasons, the order of procedure will not be in exact accordance with the above outline.

Our next paper will be concerned with the technical names and terms embraced by our study and with an introductory investigation into the various kinds of motion with which we shall be concerned in dealing with the various elementary combinations.

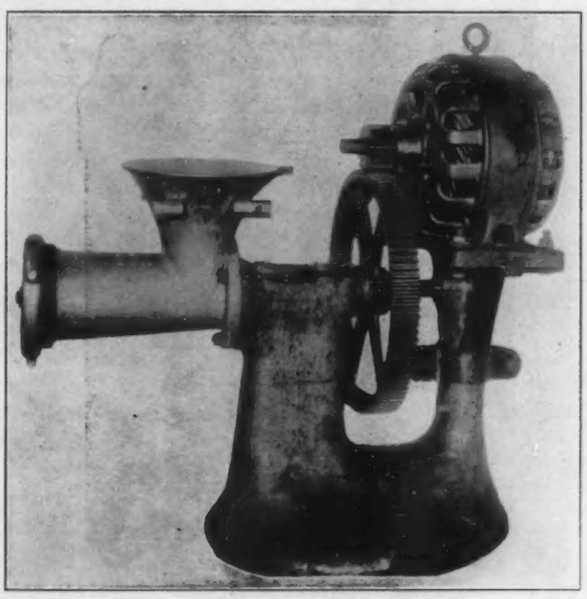
SYNOPTICAL TABLE OF THE ELEMENTARY COMBINATIONS OF MECHANISM.

Mode of transmission of motion.	Directional Relation Constant. Velocity-ratio, Constant.	Directional Relation Constant. Velocity-ratio, Varying.	Directional Relation Changing Periodically. Velocity-ratio, Constant or varying.
I. By rolling contact.	Rolling cylinders, cones and hyperboloids; pitch-circles of circular gear-wheels and sectors.	Pitch-lines of non-circular gearing, complete or sectoral.	Pitch-lines for mangle-wheels and mangle-racks; limited alternate motions.
II. By sliding contact.	Tooth-curves; segmental cams; screws; worm gearing.	Tooth-curves for non-circular gearing; cams; pin and slotted lever; irregular worm gearing; stop motions.	Cams in general, pin and slotted lever; double screw; swash-plate; escapements.
III. By wrapping connectors, or belt gearing.	Band or belt and pulleys; chain and sprocket-wheel.	Cam-shaped pulley and belt; fusee and chain or cord.	Cam-shaped pulley and lever, or tightener; treadle motion.
IV. By link-work.	Equal cranks with link; lever with proportional links; bell-crank and links.	Equal cranks with link; unequal cranks with link; Hooke's universal joint.	Crank or eccentric and pitman; ratchet-wheels and clicks; unequal cranks and link.
V. By reduplication.	Cord and pulley; pulley-blocks with parallel ropes or chains.	Pulleys, with rope or chain not parallel.	

INDUSTRIAL

A COMPACT MOTOR-DRIVEN MEAT-CHOPPING MACHINE.

A striking example of the simplicity, convenience and efficiency of electric motor drive is the application shown in the illustartion, a 10 h. p. alternating current motor gear connected to a large meat chopper. This machine has a capacity for cutting and recutting 1500 pounds of beef three times per hour, and 3000 pounds of pork twice per hour. The compact drive secured by mounting the motor on the chopper frame has the added advantage of lifting the electrical equipment above the floor; always wet and more or less greasy in a sausage room. Besides the protection from dirt and grease thus afforded the motor windings and parts, virtually no space is occupied by the driving apparatus. The improved sanitary conditions as well as efficiency secured by avoiding moving belts and shafting are important results of employing electric drive in the preparation of food stuffs. The self-contained construction of the present application prevents the stirring up of dust or foreign particles in the chopping room.



Motor Driven Meat Chopper.

Gear drive has also worked a considerable economy in operation, for, while the type of machine illustrated ordinarily requires 10 h. p. when belt-driven, it has been found to take only 7½ electrical h. p. with the spur transmission shown. This economy of power, as well as the low cost of the installation, is perhaps the strongest point in favor of this method of applying electric power, although the convenience, compactness, simplicity and cleanliness of this drive should not be overlooked.

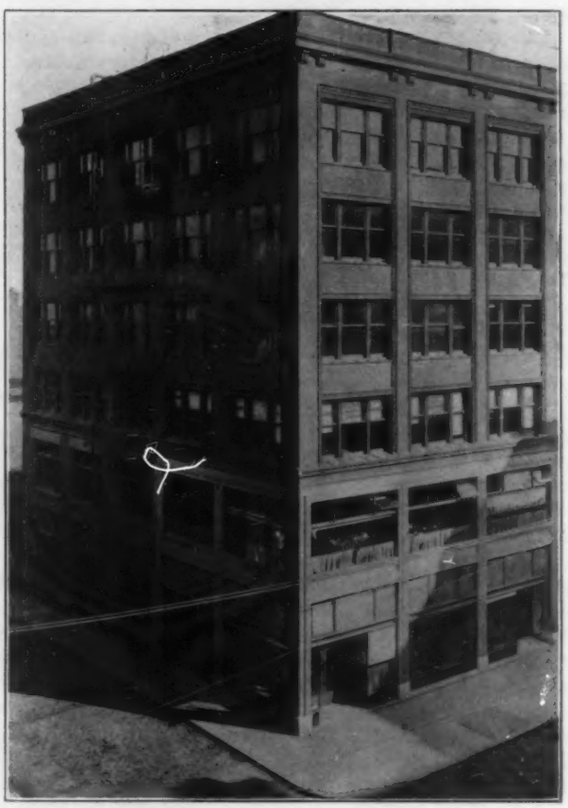
The mahine illustrated is a No. 66 Enterprise chopper, and was equipped with a Westinghouse type "CCL" three-phase induction motor for the Ziemsen Butchers' Supply Company, 2855 Archer avenue, Chicago, Ill.

ANOTHER QUICK SWITCHBOARD ORDER.

A fire at Bass, Michigan, destroyed the switchboard of the Bass Telephone Company. The Kellogg Switchboard & Supply Company received the order at 10:35 Friday, November 26th, and shipped the board complete on the first train Saturday, for Bass, which left at 10:30 a. m. Prompt service and shipments are important features of the Kellogg Switchboard & Supply Company's sales service for operating companies.

REORGANIZATION OF SAN FRANCISCO OFFICES WESTINGHOUSE ELECTRIC & MFG. CO.

The Westinghouse Electric & Manufacturing Company is just completing a scheme of interior office arrangement, which will not only greatly facilitate the handling of the company's extensive business but will prove a source of great convenience to its customers. The company occupies the entire first and second floors and the basement of the Electrical Building at 165 Second street, San Francisco.



San Francisco Offices Westinghouse Electric & Mfg. Co.

Following is a synopsis of the location of the various departments. On the second floor are to be found: The manager's office and executive staff, the chief consulting engineer's office, the treasury or collection department, the railway and lighting department, the isolated plant, mining and dredging equipment department, the erection department.

The San Francisco district manager has general charge of the company's interest in the State of Nevada and throughout California as far south as the 35th parallel, or in reality as far as Bakersfield—the southern portion of the State being handled by the Los Angeles office. The treasury department has charge of the company's collections throughout the entire Pacific Coast west of the Rocky Mountains. The railway and lighting department has charge of all negotiations involving railway equipments or large central station projects. The isolated plant, mining and dredging equipment department has the handling of the electrical requirements in such negotiations, while the erecting department consists of a corps of expert erecting and installing engineers under the direct supervision of the manager, but also closely in touch with the factory erecting department.

The first floor is given over to the industrial and power

department, the detail and supply department, the incandescent lamp department, and the correspondence department.

The industrial and power department is concerned entirely wtih motors and their various applications. Controlling and auxiliary devices incidental to motor installation as well as generating equipment for industrial plants are handled by this department, there being well defined territorial lines for the various salesmen. The detail and supply department (as the name implies) is concerned entirely with the sale of the company's various details and supplies, and is likewise territorially divided among the various salesmen.

The incandescent lamp department is responsible for the sale of the Westinghouse Lamp Company's product. The lamp stock is carried in the basement of the building, so that prompt city delivery as well as convenient inspection can be made.

The correspondence department has charge of the entire machinery stock carried at Emeryville, and looks after all requisitions, shipments and orders. All correspondence with the factory at East Pittsburg having to do with shipments, stock or delivery of apparatus is done by this department. The company's extensive files and records are also handled by this department. At the company's Emeryville warehouse there is (in addition to the regular San Francisco force) a repair shop equipped with all necessary tools and apparatus for the speedy repair of electrical machinery, and an efficient corps of winders and machinists always are available.

TELEPHONE TRAIN DISPATCHING—NORFOLK & WESTERN RAILROAD.

The Norfolk & Western Railroad has recently placed orders for four complete telephone train dispatching circuits from Norfolk to Crewe, 27 stations, 130 miles; Crewe to Roanoke, 33 stations, 126 miles; Williamson, West Virginia, to Portsmouth, Ohio, 22 stations, 113 miles; and Portsmouth, Ohio, to Columbus, Ohio, 22 stations, 100 miles. These circuits, in addition to the two circuits now in operation between Roanoke and Bluefield and between Bluefield and Williamson, West Virginia, will complete the telephone train dispatching equipment for the entire main line between Norfolk and Columbus, Ohio, about 700 miles with about 125 stations equipped. The telephone apparatus for all these circuits was purchased from the Western Electric Company, the manufacturer of the standard "Bell" telephones used by the entire Bell system. Mr. W. C. Walstrum, superintendent of telegraph, reports that the two circuits now in operation are giving excellent service.

PRINTING PRESS CONTROLLERS.

The General Electric Company has developed a complete line of CR controllers designed to meet the requirements and severe service of small direct-current electrically operated printing presses. In their design special attention has been given to such necessary features as no-voltage protection, overload protection, push button stop and jog, ruggedness of construction, and accessibility.

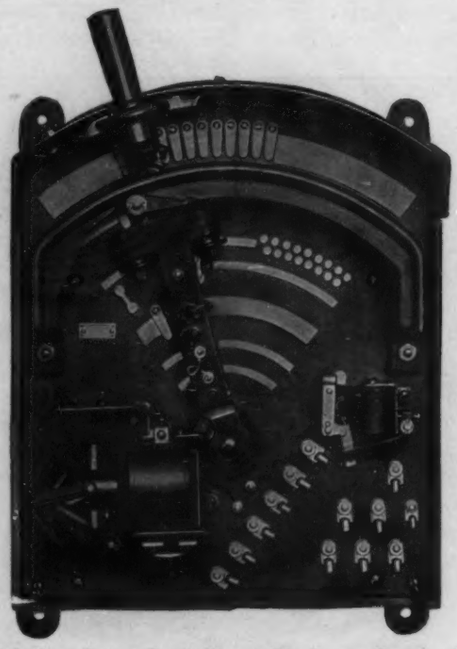
All controllers in this line have no-voltage protection. This consists of a contactor mounted in the lower left-hand corner of the slate front. The CR 169 has been designed so that upon failure of voltage the starting arm returns automatically to the off position. In addition, the controller arm is provided with a movable armature which may be adjusted so that the motor can be run only at a certain predetermined speed. All the other controllers of this line have been so designed that the contactor opens when the voltage fails and the contactor cannot be closed until the controller handle has been returned to the off position.

Since the armature circuit is made and broken by the contactor and not on the switch contacts, there is no arcing on the contacts. This eliminates the burning of the contacts which would necessarily result in roughening the surface, causing imperfect contact and their rapid destruction of the contact segments. The contactor is provided with a strong magnetic blow-out which extinguishes any arc that may result when the armature circuit is opened.

When the overload release is supplied in addition to the no-voltage release, it is so connected that when it operates it will de-energize the contactor coil, opening the contactor and thus breaking the armature circuit.

In many installations it is desirable to have push buttons located at various points around the press for stopping the motor, or for "inching" the press when necessary. Some of the controllers have, therefore, been designed to have both push button stop and jog, while others have the stop feature only.

If the push button is closed while the motor is not in operation the contactor will close, providing the switch is in the starting position, completing the armature circuit through the regulating resistance. This will start the motor which



Printing Press Controller with Cover Removed.

will run very slowly, as long as the push button is held closed. If the push button is closed while the motor is running, the contactor coil will be de-energized, thereby opening the motor circuit and stopping the motor. The same push button can, therefore, be used for jogging or stopping the motor. Each controller which has the stop and jog feature is furnished with two buttons; but any number of buttons may be installed.

Standard Form P resistance units are used throughout. In the controllers having a field regulating resistance, the units are assembled upon the back of the slate front, while the armature resistance, whether for starting or regulating duty, is assembled in a separate box. When a dynamic brake is supplied the resistance is in most cases external, but in some controllers it is self-contained.

The controllers are provided with renewable segments for armature control, while button contacts are used for field control.

The starting resistance is designed for starting duty only while the armature regulating resistance is designed for continuous operation, as various speed changes are obtained by varying the amount of resistance in the armature circuit.

NEWS NOTES

FINANCIAL.

PASADENA, CAL.—Sierra Madre is considering an issue of $100,000 bonds for the purchase of the Sierra Madre water plant, the owners of which have offered to sell to the city for $96,000.

RENTON, WASH.—The city of Renton has decided to issue bonds in the sum of $12,000 for the completion of its new water supply system which Mayor Benjamin Ticknor stated would be completed in thirty days.

LOS ANGELES, CAL.—The Board of Trustees of Calexico are arranging for a new municipal water system for which $30,000 bond were recently voted. New mains will be laid, three reservoirs built and an air pressure tank installed.

SANTA ANA, CAL.—The town of Newport Beach has voted bonds of $10,000 for water and $25,000 for gas. Proceeds will probably be utilized in buying the water plant and system now owned by J. H. Sharps, also the gas plant of the Home Gas & Electric Company to be run as a municipal plant.

DAYTON, N. M.—The City Council passed resolution 3 calling an election to be held on January 11th to vote on the question of issuing and selling bonds in the sum of $15,000 for the purpose of creating a fund with which to erect and maintain a system of water works in this city.

INCORPORATIONS.

SPOKANE, WASH.—Brown Electric Company of Chelan, $500,000, by G. P. Brown, J. G. Kennedy and C. P. Bissett.

MARSHFIELD, ORE.—Union Traction & Terminal Company of Coos Bay has been incorporated with a capital stock of $100,000, by J. N. Blake.

HOQUIAM, WASH.—The Grays Harbor Interurban Company, has been incorporated with a capital of $500,000, by Eldridge Wheeler of Montesano.

LOS ANGELES, CAL.—Los Angeles Meter Co., capital stock $10,000, by William Shade, J. G. Orth, A. W. Ballard, J A. Greenwood and John Morris.

SEATTLE, WASH.—The Pacific X-RAY Coil Manufacturing Company has been incorporated with a capital of $10,000, by F. L. Heidrich, Eighth avenue S. and Adams street.

LOS ANGELES, CAL.—Lordsburg and San Dimas Gas Company, capital stock $50,000, by C. S. S. Farney, J. H. Badger, V. M. Porter, W. S. Morse and W. T. Collins.

SAN FRANCISCO, CAL.—Hawkins Electric Company, capital stock $20,000, shares $100 each. subscribed $300, by C. W. Kilpsch, D. L. Anthony and O. T. Barber, 1 share each.

SEATTLE, WASH.—New Westminster-Mission Light & Power Company has been incorporated with a capital stock of $50,000 for the supply of light to the town of Mission City, thirty miles up the Fraser river.

EL CENTRO, CAL.—Evergreen Mutual Water Company, with capital of $10,000. The company will supply water for the Stormer tract at Brawley. Incorporators are: D. A. Stormer, A. J. Albert, Godwin A. Mellen.

RED BLUFF, CAL.—The Deer Creek Power Company has filed articles of incorporation. The power site is in Tehama County, although the principal place of business is in Chico. The capital stock is $100,000, divided into 1000 shares of $100 each, $7000 being subscribed, by C. C. Royce, W. J. O'Connor, A. G. Eames, T. H. Barnard, B. Cusick, Thos. N. Crew and Park Henshaw, $1000 each.

WHITE SALMON, WASH.—The Columbia River & Mount Adams Railroad Company has been incorporated with capital stock of $2,000,000 to build an electric railway from some point on the Columbia River in Klickitat County northerly through parts of Klickitat, Yakima and Skamania counties to a point in the vicinity of Mount Adams.

HOQUIAM, WASH.—Articles of incorporation for an extensive interurban trolley system has been filed with the Secretary of State. The capital stock is $500,000; officers: R. F. Lytle, A. L. Pain and E. O. McGlaufin of Hoquiam, W. H. Abel and Eldridge Wheeler of Montesano, A. H. Abel and P. S. Locke of Aberdeen. The franchise has recently been granted to Mr. Wheeler by the County Commissioners.

SAN JOSE, CAL.—The San Jose Railroads is the name of a new corporation that filed its articles recently. It proposes to take over the First Street railroad line and operate it in connection with the Santa Clara lines. The men interested are: L. E. Hanchett, president; W. R. Lawson, manager, and E. M. Rea, secretary and attorney of the Santa Clara Street line, and F. E. Fitzpatrick, who is associated with John Martin of San Francisco. The capital stock is $5,000,000.

TRANSMISSION.

LODI, CAL.—The Lodi Grape Juice Association will change from steam to electrical power for the coming season.

DIXON, CAL.—The Dixon Gyrating Mill Company at Dixon, California, will increase the size of its present plant and install an additional motor.

WALLACE, IDAHO.—Electric power will probably be installed at the property of the United Lead Mining Company at Osburn this winter to operate the machinery.

VANCOUVER, B. C.—The Vancouver Island Power Company, Ltd., has applied for permission to build a dam and storage reservoir on Bear Creek and Alligator Creek, tributaries to the Jordan river.

EVERETT, WASH.—The County Commissioners have granted the Granite Falls Electric Company a franchise for electric wires and water mains over all the county for a distance of a half mile from the town limits of Granite Falls.

SALT LAKE, UTAH.—A new power plant for furnishing light and power for the Utah Agricultural College at Logan has been authorized by the Board of Trustees of the college. An appropriation of $20,000 was made by the last legislature for this purpose.

VANCOUVER, B. C.—Charles E. Rogers has filed on 200 cubic feet per second of water in Lewis River and Harvey McMunn has filed for 250 cubic feet from the east fork of the same stream, the water to be used in each case for irrigation and electric power.

ROSWELL, N. M.—Mr. Jos. M. Swaziek of El Paso has been here for several days looking into conditions as he expects to locate in the valley in the near future. Mr. Swaziek stated that he will put in an electric power and pumping plant on Penasco river. The power right has already been secured.

LOS ANGELES, CAL.—Trust deeds involving $30,000,000 in bonds and executed in favor of the Harris Trust and Savings Bank of Chicago and Los Angeles Trust & Savings Company of this city were filed in the counties of Southern California by the Southern California Edison Electric Company. In this action the company legally establishes financial organization of new company. Part of this money will be spent in construction of two great power plants on Kern river.

TRANSPORTATION.

LOS ANGELES, CAL.—The Los Angeles Railway Company bought a franchise for Alpine street from Main to Buena Vista, and from Main to San Fernando, of the Council for $100.

LOS ANGELES, CAL.—A car line to connect Dolgeville and Alhambra with Covina by electric line is said to be planned by the Pacific Electric. Engineers have finished the survey.

MOUNT VERNON, WASH.—It is announced that Stone & Webster will build the proposed interurban from this place to Mt. Vernon and Sedro Woolley and it is reported that Richard T. Laffin, representing the Stone & Webster, announces that work will begin in the near future.

CHIHUAHUA, MEX.—Plans and specifications in detail showing route and approximate cost of projected electric railway which will connect Guadalajara with the town of Chapala on Lake Chapala, have been prepared by engineers of Chapala Hydroelectric & Irrigation Company.

SAN ANTONIO, TEX.—The survey for the interurban line from San Antonio to Fort Worth has been completed here. C. L. Hodges of Chicago, chief promoter, declares laying of tracks will begin within two months. The proposed route is through New Braunfels, San Marcos, Austin and Hillsboro.

SANTA CLARA, CAL.—The Commercial League of Santa Clara is working to secure a right of way through the lands northwest of the city for the extension of the street car system north to meet the line which is to run south from Palo Alto, and which is ultimately to form a through electric line from San Francisco to San Jose.

LOS ANGELES, CAL.—The city will protest against the application of the Pacific Electric Company which desires to obtain permission to build a bridge over the Los Ceritos slough, a part of the San Pedro harbor. The bridge is desired as part of the line to be built by the Pacific Electric from Long Beach to San Diego via Wilmington.

SAN FRANCISCO, CAL.—A. H. Lohman, San Francisco, is making preliminary surveys for the proposed electric line across the mountain to La Honda and the Big Basin. As proposed, the road will start at Red Wood and go to Woodside, from where two routes are under consideration. The approximate cost of the proposed line is estimated at $1,000,000.

WHITE SALMON, WASH.—Adolph F. Suksdorf and others of Spokane have formed the Columbia River & Mount Adams Railway Company to build an electric railway from some point on the Columbia River in Klickitat County, thence through parts of the same county, Yakima and Skamania counties to a point in the vicinity of Mount Adams. The incorporation is for $2,000,000.

OAKLAND, CAL.—Application was made at a meeting of the Council committees last night by the Peninsular Railroad Company for a street railway franchise for a road starting at Fourteenth and Franklin streets, thence down Franklin street to Twenty-first, down Twenty-first to the Sixteenth street depot, forming a loop at the Sixteenth street depot to Eighteenth street, back on Eighteenth street to Brush street, up Brush to Twenty-first and thence back to Fourteenth and Franklin streets.

STOCKTON, CAL.—Construction work is being rushed on the Central California Traction Company's extension of the line designed to connect Sacramento and Lodi, and the company expects to have the interurban road ready for operation by the middle of next summer. One million dollars, it is reported, is the estimated cost of constructing the extension and equipping the road for business. Almost all the grading to the Sacramento County line in San Joaquin County has been finished and graders are now working in Sacramento County. S. B. McLenegan, general manager, is in charge.

ILLUMINATION.

VAN HORN, TEX.—John E. Cox, owner of the Van Horn water works, will put in an electric light plant soon to supply the whole town with light.

LOS ANGELES, CAL.—The Covina Valley Gas Company announces that it proposes to extend mains eastward to Lordsburg, on the city limits of Pomona.

LOS ANGELES, CAL.—For the installation of 200 electric lamps for East Hollywood lighting district the only bid was by the Pacific Light & Power Company.

SANTA ROSA, CAL.—The Board of Supervisors at their last meeting granted the franchise petitioned for by the Cloverdale Light &Power Company to that corporation.

PHOENIX, ARIZ.—The City Council has instructed the city attorney to take steps toward obtaining permission from Congress for the city to bond itself for $300,000 for constructing a municipal lighting plant.

SUISUN, CAL.—The Rochester Oil Company recently resumed sinking for oil in the property near Suisun, California. This company is now furnishing natural gas which they encountered while boring for oil previously.

MERCED, CAL.—The Merced Falls Gas & Electric Company is preparing for a new sub-station to be erected on the lot which adjoins the plant on Fifteenth street in this city. The new station will be about 30x50 feet and will be built of concrete with a steel frame.

ALAMEDA, CAL.—The $300,000 electric light plant of the city of Alameda was endangered by fire December 26 when a vacant building at the south end of Park street immediately adjoining the plant, was gutted by fire. The old frame structure burned fiercely before the fire was conquered.

REDWOOD CITY, CAL.—Attorney Archer Kincaid, on behalf of Benjamin Cunha, has presented a petition asking that steps be taken to sell a franchise for installing and maintaining electric lights in Miramar, Halfmoon Bay and Pursima school districts. On motion of Blackburn action was postponed until the next meeting.

OAKLAND, CAL.—Negotiations by the National Electrical Lamp Company for the purchase of a block of land in West Oakland lying between Peralta and Campbell and Sixteenth and Seventeenth streets, have been completed. It is the purpose of the company which has already established plants in most of the principal cities of the United States, to erect a fine factory on the new site.

WATERWORKS.

SALEM, ORE.—Resolutions proposed by Mayor Rodgers were adopted by the City Council. Salem shall own and operate a water supply system to bring water from Bretonbush.

LOS ANGELES, CAL.—A Goerz & Co., of London, have purchased control of La Fey Anexas mines in Zacatecas district and a bid for a pumping plant will be installed to handle water on property.

OAKLAND, CAL.—As a result of the meeting last week between members of the Park Commission, the secretary was authorized to advertise for bids for the resurfacing of the playground in Bushrod Park and for the laying of pipes in Lakeside Park.

SALEM, ORE.—At the last meeting of the Council the mountain water matter was referred to a special committee empowered to take all the preliminary steps for submission to the voters of the question of building a system to bring the city a pure water supply from Bretonbush and for acquiring the plant of the Salem Water Company and building reservoirs.

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